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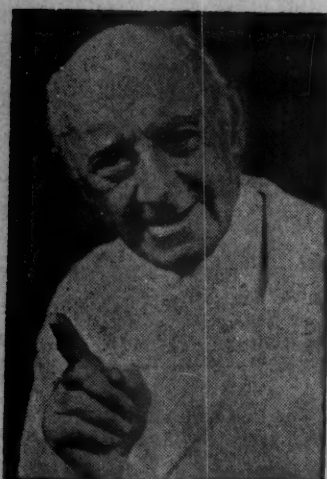
DELAYED INTERNAL FIXATION OF COMPOUND BATTLE
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DELAYED INTERNAL FIXATION OF COMPOUND BATTLE FRACTURES IN THE MEDITERRANEAN THEATER OF OPERATIONS

A FOLLOW-UP STUDY IN THE ZONE OF INTERIOR

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PART I

INITIAL SURGERY is the surgery which the war wounded receive in the hospitals of the combat zone as soon after wounding as is feasible. In compound fractures or soft-part wounds of the extremities, it is the excisional phase, or "débridement" (Anglicized usage), which is designed to save life and limb and prevent infection. Practically, it is the arrest of hemorrhage and the excision of tissue devitalized by the missile together with the adequate dressing and splinting of the extremity without effort at definitive reduction of a fracture.

Reparative surgery¹ is the secondary phase of military surgery performed in the Base Hospital, usually five to ten days after wounding. It is designed to prevent or cut short infection and to promote healing of the wound created by the missile and initial surgery. It is premised upon complete initial surgery resulting in a clinically clean wound when the latter is examined for repair. The principles of reparative surgery may be briefly stated as thorough wound visualization to determine the adequacy of initial surgery, excision of residual dead tissue, closure of wounds by suture or skin graft, the obliteration or dependent drainage of residual dead space and adequate splinting. Reparative surgery of compound fractures necessarily includes the adequate reduction and maintenance of reduction of the fractures. It includes the partial or complete closure of soft-part wounds compounding the fractures. Aerobic and anaerobic bacterial flora are recognized as present but the old concepts of avoiding surgery in a recognized bacterially infected field or of the "wound barrier against infection" are ignored.

The objectives of reparative surgery of compound fractures² are: 1. Minimum wound sepsis. 2. Maximum fracture reduction (maintained). 3. Rapid wound healing with minimum scar formation. 4. Maximum functional restoration of the extremity from wounds of muscle and nerve as well as bone.

In the Mediterranean Theater of Operations in an effort to achieve these objectives, adequate blood replacement therapy, routine systemic penicillin therapy and precision surgery are employed.

Prior to the days of reparative surgery, inadequate reduction had been

accepted in some cases, particularly in fractures about joints, fractures of the tibia and fibula and fractures of both bones of the forearm rather than risk stirring-up and establishing infection by an open operation, with or without internal fixation. An almost completely unconquered fracture problem was the segmental defect without contact of fragments which resulted from bone loss in some cases, particularly in the humerus. A pertinent observation of that period was that the unreduced, frequently manipulated or "adjusted," and, therefore, traumatized fracture, was often septic. As reparative surgery of compound fractures was conceived, it was planned that delayed internal fixation would be employed to achieve and maintain reduction in those fractures recognized as problems and in those in which reduction was not achieved by other methods. Following early successes as measured by fracture stabilization and wound healing, the procedure was extended to include many fractures whose contour permitted a rigid stabilization by plates or screws in order to gain the advantages offered by maximum reduction and stabilization of the fracture. The fractures permitting stabilization are in a definite minority, however, and other methods of management usually were employed. However, in some comminuted fractures, particularly those with bone loss, wire-loop fixations were used to achieve the best possible bony contact. Internal fixation is employed as an adjuvant of fracture management and fracture management comprises only one of the problems presented by a compound battle fracture.

A major problem of the management of battle fractures is the salvage of denuded external cortex of bone which will sequestrate unless soft parts become reattached and it thereby has a blood supply reestablished. If wound sepsis intervenes, soft parts do not readhere to the bone and sequestration is almost inevitable. Where sequestration occurs, wound healing does not occur. At the same time, fracture reduction must be achieved and maintained, projected towards bony union and the maximum functional restoration of the extremity. The well-reduced fracture is rarely septic and the compounding wounds are likely to heal under proper management. In view of these considerations, it seems reasonable to state that the *advantages* of delayed rigid internal fixation in the management of a compound battle fracture are: 1. Optimal apposition and alignment. 2. Elimination of the dead space of an unreduced fracture and its attendant traumatizing manipulations. 3. Early joint motion and muscle exercise may be permitted. 4. Multiple operating room procedures for concurrent injuries are permitted. 5. Staged procedures for the compounding wound are facilitated.

The *disadvantages* of delayed internal fixation in these injuries may be stated as follows: 1. Any periosteal stripping incident to the open reduction and placement of the metal potentially devitalizes the denuded cortex of bone. 2. The extent to which the metal interferes with the reattachment of soft parts to denuded bone enhances the chances of sequestration. 3. The trauma incident to the fixation, *e.g.*, retractor pull or vessel ligatures, may devitalize soft tissue and thereby establish a nidus for wound sepsis.

COMPOUND BATTLE FRACTURES

A nonrigid fixation as is offered by a wire loop maintains some degree of bony contact but otherwise minimizes both the advantages and disadvantages of internal fixation.

The use of delayed internal fixation in the Mediterranean Theater of Operations under the principles outlined began as a part of the reparative surgery of compound fractures in April, 1944, during the memorable days of Cassino shortly before the "Fall of Rome" and continued until the unofficial "V-M Day," when the Nazis in Italy surrendered. However, the excision of dead tissue, the closure of compounding wounds especially so as to cover denuded bone cortex and adequate drainage of residual dead space or unexcisable devitalized tissue, all designed to obviate sepsis and achieve wound healing are of greater importance in the program. Internal fixation would be doomed to failure if the other essential surgery were to be ignored.

The routine procedure for these casualties in a Base Hospital must be understood clearly. The operating room is set up for any possible indicated surgery on a compound fracture. The patient is usually properly prepared for reparative surgery five to ten days after wounding. He is anesthetized in the operating room where the encasement and dressing applied after initial surgery are removed. The extremity is cleansed, prepared and draped. The wound is visualized thoroughly by gentle retraction. Any residual dead tissue is excised and the depths of the wound are cleaned of old blood clot. The fracture site is exposed. It is there and then that internal fixation may be employed *as part of the first procedure of reparative surgery* if its advantages are obvious, *e.g.*, in condylar fractures of joints, oblique fractures of long bones which are easily reducible or segmental defects due to bone loss. Wound closure, usually with drainage, completes this stage of reparative surgery. In the great majority of cases reduction is attempted by traction or manipulation. If adequate reduction is not achieved and the contour of the fracture permits, internal fixation may be performed at another operation, perhaps after wound healing. Internal fixation has not been reserved for the ideal case but has been employed frequently in fractures that are major problems under any plan of management, *e.g.*, an avulsion of the soft parts of the arm exposing the shaft of the humerus for several inches, a grossly displaced septic fracture of the femur 66 days after wounding, with a huge soft-part wound—a situation hardly included in the realm of reparative surgery.

The results as observed in this Theater prior to evacuation of the patients to the Zone of Interior had been judged very satisfactory, particularly when they were viewed in the light of the problem for which the fixation was used. However, it was desired to know the facts. Upon the recommendation of the Surgeon, M.T.O., U.S.A., the author was ordered to the Zone of Interior and, with the approval and coöperation of the Surgery Division, Office of the Surgeon-General, a follow-up study on cases from this Theater was conducted.

PROCEDURE FOR THE SURVEY

Twenty-four designated General Hospitals were visited, and through the

coöperation of the Chiefs of Orthopedic Sections, patients in the hospital upon whom delayed internal fixation had been performed in the Mediterranean Theater of Operations, were examined on the wards or in clinics with their overseas and current records and roentgenograms. If the patients were on pass or furlough, their records were studied with the Chief of Section, or his ward officer. Clinical abstracts on patients already given a certificate of disability discharge, referred to Convalescent Hospitals, or discharged to duty, were studied. Five patients had fractures in two different bones in which internal fixation was employed. These are recorded as separate cases. From these observations, 300 complete case reports were assembled, providing the majority of the data for the compilation of the tables. Thirty-two additional patients were located as on duty, demobilized from the army or in Convalescent Hospitals not visited. This status gives reasonable assurance that their fractures are united and that their wounds are healed, therefore, the results are very satisfactory. They have been classified as "A" results in the appended tables, recording the results according to type fixation because the fixation used is known. They are not included in the tables recording the results according to indications but are added as Group X under "A" results.

The operative procedures were performed upon the 332 cases in 1944, in 18 Base Hospitals, by approximately 50 surgeons representing a cross-section of the surgical proficiency of the Theater. The great majority were performed between the "Fall of Rome," on June 4, 1944, and the conclusions of the Southern France and the Gothic Line Campaigns about November 1, 1944. This survey was conducted between March 16 and April 26, 1945.

EVALUATION OF RECORDED INDICATIONS

Particular study was made of the recorded indication and reason why the overseas surgeon chose delayed internal fixation as an adjuvant to fracture management and the results achieved and observed were evaluated in terms of the problems that required solution. The indications were divided arbitrarily into three groups: Obligate, desirable, and elective. Illustrative case histories are appended to illustrate each group and subgroup.

I. *Obligate*: Obligate indications were subdivided into five groups:

1. Bone loss producing a segmental defect without contact of fragments or a persistent distraction of fragments. Either, if allowed to persist, would be expected to result in nonunion. (Cases 1, 2, 3 and 4.)
2. The failure to achieve adequate reduction by traction or manipulative measures, a status expected to result in either nonunion, delayed union, or malunion unless improved. (Cases 3, 4, 5 and 6.)
3. Fractures about joints demanding reconstruction of joint congruity if a satisfactory result was to be expected. (Case 7.)
4. Massive soft-tissue loss precluding routine methods of management and demanding repeated staged procedures in an effort to achieve wound healing. (Case 8.)

COMPOUND BATTLE FRACTURES

5. Associated nerve injury, optimum management demanding early stabilization of fractures, possibly with deliberate shortening of the bone to permit approximation of nerve ends. (Case 9.)

The fixations in the obligate indications were performed either at the first operation of reparative surgery or at a later procedure, except the Obligate-2 subgroup. It, of necessity, represents a group fixed at a later operation.

II. *Desirables*: The desirable indications necessarily varied with the bone involved. All the fixations were performed at the first operation of reparative surgery.

1. *Femur*. It was considered desirable to stabilize fractures of the shaft if their contour permitted a reasonably rigid stabilization in anatomic reduction because by so doing, union in anatomic alignment could be anticipated, early motion of the knee joint would be permitted, and subsequent wound management by staged procedures would be facilitated. Moreover, these patients could be evacuated to the Zone of Interior within four to six weeks in preference to ten to 12 weeks after wounding, as was the average for fractures of the femur treated in skeletal traction, a factor of no little importance in a busy Theater of Operations. (Case 10.)

2. *Tibia and Fibula*. The desirable indications were fractures which permitted accurate reduction and stabilization by the use of two or more screws. In general, this group were oblique fractures, which, by experience, were difficult to maintain in adequate reduction by nonfixation measures. (Case 11.)

3. *Humerus*. No indications were classified as desirable.

4. *Radius and Ulna*. The desirable indications were all fractures fixed without obligate indications. Fractures of the forearm have proven difficult to reduce and stabilize, and the results achieved without internal fixation have not been satisfactory. Therefore, it was deemed desirable to achieve adequate reduction by means of internal fixation providing the contour of the fracture was favorable. (Case 12.)

III. *Elective*. Fixations performed at the first operation of reparative surgery in cases where the surgeon presumably chose internal fixation in preference to nonfixation methods without desirable or obligate indications.

1. *Femur*. All indications classified as elective were wire-loop fixations presumably used to insure contact of major comminuted fragments which otherwise might have caused some difficulty. (Case 13.)

2. *Tibia and Fibula*. Indications were classified as elective if they were neither obligate nor desirable. All the fixations classified in this group were platings except one which was a wire-loop. While this group is classified as elective, it is considered a rather strict classification because adequate reduction of fractures of the tibia and fibula has been very difficult to obtain by other measures. But because other measures were not tried initially and, therefore, the indications could not be classified as an Obligate-2, and because it has been previously considered hazardous to strip the periosteum for the application of a plate, the group has been classified as elective, in the sense that

PLATE I



PLATE I.—Case 3: A. Roentgenograms, 13 March, 1944, one month after injury, with the extremity in skeletal traction, revealing distraction and gas abscess formation.

B. Partial wound closure and gaping dependent open wound for drainage at reparative surgery on 15 March, 1944.

C. Staged closure of the remaining portion of posterior wound over a small drain on 21 March, 1944.

PLATE II

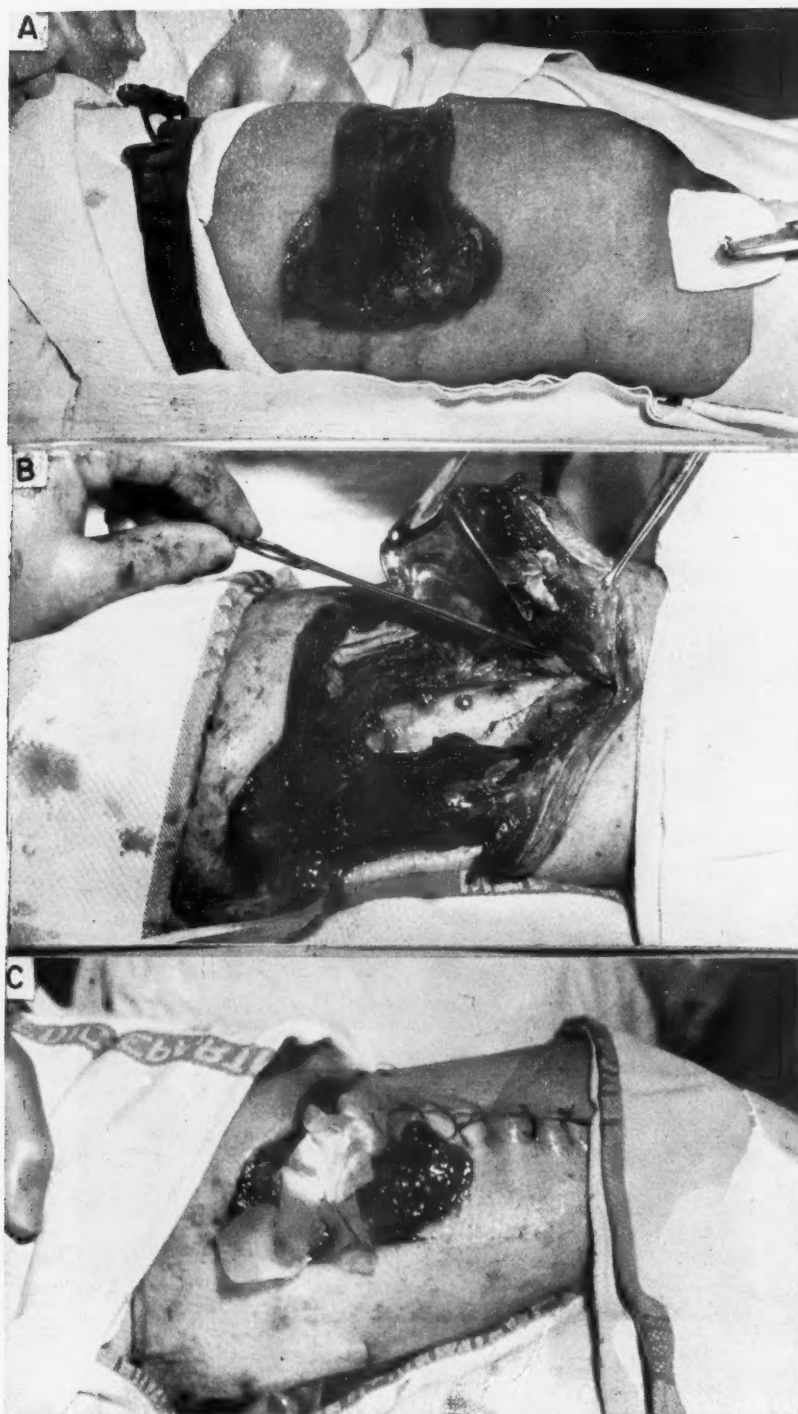


PLATE II.—Case 8: A. Compounding wounds of the right thigh at reparative surgery, 9 April, 1944.

B. The internal fixation by four screws. Minimal periosteal stripping was required.
C. Partial closure and loose packing of the dead space, with dependent drainage through a separate incision in the posterolateral fascial plane.

PLATE III



A

B

C

PLATE III.—Case 11: A. 15 July, 1944, four weeks after reparative surgery. Healed sutured wound over the tibia and the granulating relaxing incision. The latter might have been split-skin grafted.

B. The healed lateral wound through which drainage was established for a few days.

C. Roentgenograms made pre- and postoperative. The upper screw missed the drill hole in the distal cortex.

COMPOUND BATTLE FRACTURES

the operating surgeon elected to risk the hazard in order to achieve and maintain reduction. (Cases 14, 15, 16 and 17.)

3. *Humerus*. All indications that did not fall under the five subgroups of obligate were classified as elective. In general, the operating surgeon electively chose internal fixation as an adjuvant to fracture management without first attempting nonfixation methods. (Case 18.)

4. *Radius and Ulna*. No indications were classified as elective.

CLASSIFICATION OF RESULTS

It was found necessary to classify the results into six groups, taking into consideration union of the fracture, wound healing, with or without removal of the metal and sequestra, and whether either fractures or wound healing was delayed beyond average expectancy. Examples of each class are illustrated in the case histories.

Result "A": This group represents the perfect results in which the fractures united in or near to anatomic alignment and the wound healed solidly, without sequestration or removal of the metal. (Cases 1, 4, 7, 9, 10, 11, 12, 15 and 18.) In several femurs and tibias, the metal was removed prophylactically even though the wounds were healed, either because it was routinely considered advisable by the surgeon in charge or there was evidence of absorption about the screws.

Result "B": This group represents very satisfactory results because the fractures united in adequate reduction, and following removal of the sequestra and metal, wound healing was achieved without delay. (Cases 3, 5, 13 and 14.)

Result "Bs": This subclass is necessary only in results of internal fixation of the tibia. Fracture union was achieved and, following removal of the sequestra and metal, the wounds healed, but the sequestration was massive and, therefore, full weight-bearing stability was delayed. (Case 16.) The end-results in these cases will be satisfactory, but the sequestration resulting was hazardous to bony continuity and stability prior to union, and the extremities required brace protection for several months.

Result "C": This group represents anticipated satisfactory results as the fractures are united, but the wounds are not yet healed. In some, the sequestra and metal have not been removed. (Case 6.) Because wound healing has been achieved readily in the Result "B" group, wound healing is anticipated in these cases following indicated surgery. In the remainder, additional sequestrectomies and plastic procedures should achieve wound healing.

Result "D": This group represents less favorable results as wound healing and, in the great majority, fracture union was not achieved until the sequestra and metal were removed, and the time required for both union and wound healing exceeded normal expectancy. (Case 8—humerus.)

Result "E": This group includes the cases with healed wounds, without sequestration or removal of metal, but without union of the fracture. While the result cannot be considered completely satisfactory, the nonunion must be

evaluated against the chances of nonunion had internal fixation not been employed. (Case 2.)

Result "F": This group is comprised by the bad results which must be evaluated also against probabilities of an unfavorable result had not the internal fixation been employed. The fractures did not unite and the wounds did not heal. In several, following removal of metal and sequestra, the wounds have healed, but bone grafting procedures will be necessary in an effort to achieve bone union. (Cases 17 and 8—radius-ulna.)

Data: The data is compiled in the appended tables. The results have been evaluated in relation to the type of fixation and to the indication. Emphasis has been placed upon indications because they represent the problem for the solution of which delayed internal fixation was chosen as an adjuvant to fracture management.

In Section III, a summary of all results except A and B is presented, and should be studied in an evaluation of this data.

It is regretted that no comparable data are available in similar groups treated without delayed internal fixation. An effort was made to obtain that information but none of the hospitals had them compiled or available.

I—RESULTS IN RELATION TO TYPE OF FIXATION

Code of Results (Summarized)

Result A—Union of the fracture and wound healing without sequestration or removal of metal.

Result B—Union of the fracture, and following removal of sequestra and metal, the wounds healed.

Result Bs—The same as B but the sequestration was massive, so as to prejudice the strength of the bone.

Result C—Union of the fracture but the wounds are as yet unhealed, however, in many, the metal and sequestra have not been removed.

Result D—Union of the fracture and wound healing after removal of metal and sequestra, but the time required for each was prolonged appreciably.

Result E—Nonunion of the fracture but wound healing without sequestration or removal of the metal.

Result F—Nonunion and sequestration without wound healing (in five cases the wounds healed after removal of sequestra and metal).

Three of the A results had angulated tibias but only in one case, a fracture of the lower third, was the angulation excessive. At the time of fixation, the fibula may be shortened one-quarter- to one-half-inch to allow for tibial collapse, especially in lower third fractures.

COMPOUND BATTLE FRACTURES

TABLE A

FEMUR

Code of Results	A	B	C	D	E	F	Total	%
Plates	41 57%	12 ^a 16.6%	5 7%	5 7%	2 2.7%	7 9.7%	72 100%	49.3%
Screws	39 73.6%	7 ^b 13.2%	6 11.3%		1 ^c 1.9%		53 100%	36.3%
Wire	12 57.1%	5 ^d 24%			2 9.5%	2 9.5%	21 100%	14.4%
Totals	92 ^e 63%	24 16.4%	11 7.5%	5 3.4%	5 3.4%	9 6.1%	146 100%	100%

^a One had rather heavy sequestration but grafting was not required.

^b One had precarious union but original injury was severe, with bone loss.

^c Only four months after injury—still in spica and may unite.

^d One Parham band was used in this group.

^e Operation was performed after wound healing in five cases. The average time since wounding in four cases was 35 days. The time-interval in the 5th case was not recorded.

TABLE B-1

TIBIA-FIBULA

Code of Results	A	B	B-s ^b	C	D	E	F	Total	%
Plates	16 ^a 37.3%	10 23.3%	6 14%	2 4.7%		1 2.3%	8 18.6%	43 100%	57.3%
Screws	19 73%	2 ^a 7.7%	2 7.7%	3 11.5%				26 100%	34.6%
Wire	3 50%	2 ^a 33.3%					1 16.6%	6 100%	8.1%
Totals	38 ^a 50.7%	14 18.7%	8 10.7%	5 6.7%		1 1.3%	9 12%	75 100%	100%

^a One "A" plate, one "B" screw and one "B" wire fixation were delayed in fracture and wound healing but not sufficiently long to warrant a "D" classification, and sequestration was *nil* or minimal.

^b This subgroup united and wound healing was obtained after removal of metal and sequestra, but the sequestration was so massive that the union needed protection for several months, and there was danger of refracture.

^c Operation was performed after wound healing in five cases. The average time since wounding in four cases was 28 days. The time-interval was not recorded in the 5th case.

TABLE B-2

TIBIA-FIBULA

Results of plating of fibula without fixation of the comminuted tibia. (The procedure maintains length, and, in effect, converts the fracture into one of the tibia only. Union of the fractures and healing of the compounding wounds of both the tibia and fibula are classified)

Code of Results	A	B ^a	E
Total cases	13 100%	10 ^b 77%	1 7.7%
			2 ^c 15.4%

^a The tibial fracture and wound healed. Sequestra and metal were removed from the fibula prior to wound healing.

^b In the A results two cases required sequestrectomy of tibia before wound healing.

Three cases may need reinforcing bone grafts for stability because of bone loss at injury.

^c A four-inch defect in tibia-length was strutted, anticipating a bone grafting prodedure. The other case was a nonunion of a tibia in which there was bone loss and minimal contact of fragments.

TABLE C
HUMERUS

Code of Results	A	B	C	D	E	F	Total	%
Plates	16 ^a 64%	3 12%	1 4%	1 4%	1 4%	3 12%	25 100%	37.3%
Screws	10 71.4%	3 21.4%	1 7.2%				14 100%	20.9%
Wire	19 68%	2 7.2%	3 10.8%		3 10.8%	1 3.6%	28 100%	41.8%
Totals	45 ^b 67.2%	8 ^c 12.1%	5 7.4%	1 1.5%	4 ^d 5.9%	4 5.9%	67 100%	

^a One was delayed in uniting but the wounds healed promptly.^b In five cases, averaging 38 days since wounding, operation was performed after wound healing.^c In one case operation was performed after wound healing, 20 days after wounding.^d In one case operation was performed after wound healing, 25 days after wounding.TABLE D
RADIUS-ULNA*(If the metals were mixed in a given case, the more massive metal is classified)*

Code of Results	A	B	C	D	E	F	Total	%
Plates	9 60%	2 13.4%			1 6.7%	3 20%	15 100%	48.4%
Screws	2 ^a 100%						2 100%	6.6%
Wire	10 71.4%	3 ^b 21.4%			1 7.1%		14 100%	45.0%
Totals	21 ^c 67.8%	5 16.1%			2 6.4%	3 9.6%	31 100%	

^a One deliberate ulna shortening, to permit contact of radial fragments with bone loss, was not a good functional result because of soft-tissue fibrosis and synostosis.^b One case was a fracture of both bones, each wired. Only the wire in the radius was removed.^c In four cases, averaging 29 days after wounding, operation was performed after wound healing.TABLE E
COMPOSITE FOR ALL BONES

Code of Results	A	B	Bs	C	D	E	F	Total	%
Plates (total)	92 54.8%	28 16.7%	6 3.6%	8 4.8%	6 3.6%	7 4.1%	21 12.4%	168 100%	50.6%
Femur	41 73.8%	12 12.6%		5 10.5%	5 1%	2 1%	7 100%	72	
Tibia-fibula	16	10	6	2		1	8	43	
Tibia-fibula (Fig. plating)	10	1				2		13	
Humerus	16	3		1	1	1	3	25	
Radius-ulna	9	2				1	3	15	
Screws (total)	70 73.8%	12 12.6%	2 2.1%	10 10.5%		1 1%		95 100%	28.6%
Femur	39 73.8%	7 17.3%		6 4.3%		1 8.7%		53 100%	
Tibia-fibula	19	2	2	3				26	
Humerus	10	3		1				14	
Radius-ulna	2							2	
Wire (total)	44 63.8%	12 17.3%		3 4.3%		6 8.7%	4 5.8%	69 100%	20.8%
Femur	12 63.8%	5 17.3%				2 8.7%	2 5.8%	21 100%	
Tibia-fibula	3	2					1	6	
Humerus	19	2		3		3	1	28	
Radius-ulna	10	3				1		14	
Grand total	206 61.5%	52 15.7%	8 2.4%	21 6.3%	6 1.8%	14 4.2%	25 7.5%	332 100%	

COMPOUND BATTLE FRACTURES

II—RESULTS IN RELATION TO INDICATIONS

Code of Indications (Summarized)

Obligates: Fixations were at either first, or later, operation of reparative surgery.

- 1—Bone loss producing a segmental defect or persistent distraction, either of which accepts nonunion as almost inevitable.
- 2—Inadequate reduction by nonfixation measures, *e.g.*, skeletal traction, "hanging cast," manipulation.
- 3—Condylar fractures at knee or elbow.
- 4—Massive soft-tissue loss which demanded repeated staged procedures and, preferably, a fixed fracture.
- 5—Associated nerve trunk injuries, the optimum management of which required fracture fixation.

Desirable: All fixations were at first operation of reparative surgery.

Femur—Rigid stabilization by plates or screws, nonobligate.

Tibia-fibula—Rigid stabilization by screws only, nonobligate.

Radius-ulna—All type fixations that were nonobligate.

Elective: All fixations were at first operation of reparative surgery.

Femur—All wire-loop fixations, nonobligate.

Tibia-fibula—All platings (including fibula platings) and wire-loops, nonobligate.

Humerus—All type fixations that were nonobligate.

Group X, representing 32 cases of known favorable (A) results but unknown indications, is not included in the tables in this section except as added A results.

TABLE F
FEMURS

Code of Results	A	B	C	D	E	F	Total	
<i>Obligates:</i>								
1	5				2	1	8	
1 and 2	3		1				4	
1 and 4		1	1			1	3	
2 ^a	16	4	5	2	1	5	33	
3	6	2					8	
4	1						1	
Total obligates	31	7	7	2	3	7	57	(41.9%)
Desirable	49	13	4	3	1	2	72	(53.0%)
Elective ^c	2	4			1		7	(5.1%)
Total	82	24	11	5	5	9	136	(100%)
Group X ^d	10						10	
Grand total	92	24	11 ^b	5	5	9	146	
	(63%)	(16.4%)	(75%)	(3.4%)	(3.4%)	(6.3%)	(100%)	

^a The Obligate-2 indications averaged 32 days from wounding to the surgery for the fixation, indicating 20 to 25 days in traction without reduction.

^b This group now average only seven months since wounding.

^c All elective fixations were wire-loops.

^d Results but not indications are known.

TABLE G
TIBIA-FIBULA

Code of Results	A	B	Bs*	C	D	E	F	Total
Obligates								
1	2	1					1	4
2	4	4		2		1	2	13
3	1							1
Total obligates	7	5		2		1	3	18 (29.5%)
Desirable (all screws)	11	2	2	2				17 (27.8%)
Elective ^a (25 platings, 1 wire)	6	7	6	1			6	26 (42.7%)
Total	24	14	8	5		1	9	61 (100%)
Group X ^d	14							14
Grand total	38	14	8*	5		1	9	75b (100%)
	(50.7%)	(18.7%)	(10.7%)	(6.7%)		(1.3%)	(12%)	

* This subgroup united and wound healing was obtained after removal of metal and sequestra, but the sequestration was so massive that the union needed protection for several months, and there was danger of refracture.

^b Thirteen were compound fractures due to injury rather than a penetrating missile. The results achieved in this group by plating (11), and multiple screws (2), were as follows:

A	B	Bs	C	D	E	F
3	3	3	2		1	1

^a Platings of the fibula are classified as elective indications but they are not included in this table.

^d Results but not indications are known.

TABLE H
HUMERUS

Code of Results	A	B	C	D	E	F	Total
Obligates:							
1	7		1		3	1	12
1 and 2	2						2
1 and 4						2	2
2	10	4	2		1		17
3	4	2					6
4				1		1	2
5	1						1
Total obligates	24	6	3	1	4	4	42 (66.6%)
Elective	17	2	2				21 (33.3%)
Total	41	8	5	1	4	4	63 (100%)
Group X ^a	4						4
Grand totals	45	8	5	1	4	4	67
	(67.2%)	(12%)	(7.4%)	(1.5%)	(5.9%)	(5.9%)	(100%)

^a Results but not indications are known.

COMPOUND BATTLE FRACTURES

TABLE I
RADIUS-ULNA

Code of Results	A	B	C	D	E	F	Total
Obligates:							
1	1				1		2
1 and 2		1					1
1 and 4		1					1
2	8	2					10
2 and 4	1					1	2
4						1	1
5	1						1
Total obligates	11	4			1	2	18 (66.6%)
Desirable	6	1			1	1	9 (33.3%)
Total	17	5			2	3	27 (100%)
Group X*	4						4
Grand totals	21 (67.8%)	5 (16.1%)			2 (6.4%)	3 (9.6%)	31 (100%)

* Results but not indications are known.

TABLE J
A SUMMARY OF RESULTS IN OBLIGATE INDICATIONS
(135 cases—45%)

Obligate-1—39 cases with bone loss producing a segmental defect or with persistent distraction either accepting nonunion as almost inevitable. In seven, previous efforts at reduction were unsuccessful. In eight, soft-tissue loss added to the indication.

Code of Results	A	B	C	D	E	F	Total	%
Total Obligate—1	20	4	3		6	6	39	28.9%
	51.3%	10.2%	7.7%		15.4%	15.4%	100%	
Femur	(8)	(1)	(2)		(2)	(2)	(15)	
Tibia-fibula	(2)	(1)				(1)	(4)	
Humerus	(9)		(1)		(3)	(3)	(16)	
Radius-ulna	(1)	(2)			(1)		(4)	

Obligate-2—75 cases without adequate reduction by the nonintervention methods of skeletal traction, "hanging cast" or manipulative measures followed by immobilization.

Code of Results	A	B	C	D	E	F	Total	%
Total Obligate—2	39	14	9	2	3	8	75	55.5%
	52%	18.7%	12%	2.6%	4%	10.6%	100%	
Femur	(16)	(4)	(5)	(2)	(1)	(5)	(33)	
Tibia-fibula	(4)	(4)	(2)		(1)	(2)	(13)	
Humerus	(10)	(4)	(2)		(1)		(17)	
Radius-ulna	(9)	(2)				(1)	(12)	

Obligate-3—15 condylar fractures in which optimum reduction could be achieved and maintained only by some form of fixation at open operation.

Code of Results	A	B	C	D	E	F	Total	%
Total Obligate—3	11	4					15	11.1%
	73.3%	26.7%					100%	
Femur	(6)	(2)					(8)	
Tibia-fibula	(1)						(1)	
Humerus	(4)	(2)					(6)	

Obligate-4—4 cases with the soft-tissue loss so great, and demanding such attention, that some fixation was deemed necessary (see Obligate-1 above also).

Code of Results	A	B	C	D	E	F	Total	%
Total Obligate—4	1			1		2	4	3%
	25%			25%		50%	100%	
Femur	(1)						(1)	
Humerus				(1)		(1)	(2)	
Radius-ulna						(1)	(1)	

Obligate-5—2 cases with associated nerve injuries, the optimum management requiring fracture fixation.

Code of Results	A	B	C	D	E	F	Total	%
Total Obligate—5	2						2	1.5%
	100%						100%	
Humerus	(1)						(1)	
Radius-ulna	(1)						(1)	
Total obligates	73	22	12	3	9	16	135	100%
	54.1%	16.3%	8.9%	2.2%	6.4%	11.6%	100%	

TABLE K

SUMMARY OF RESULTS IN DESIRABLE INDICATIONS

(98 Cases—32.7%)

All fixations were performed at the first operative procedure of reparative surgery

Femur—72 cases in which it was desired to gain the advantages of a well-reduced and stabilized fracture of the femur by plating or multiple screws. Several cases actually were not stabilized but the indications were classified as desirable.

Tibia-fibula—17 cases of fracture of the tibia and fibula in which it was desired to obtain the complete reduction and stabilization afforded by open reduction and multiple screw fixation.

Humerus—

Radius-ulna—9 cases in which it was desired to obtain maximum reduction at reparative surgery rather than risk an inferior reduction by other measures.

Code of Results	A	B	Bs	C	D	E	F	Total
Femur	49	13		4	3	1	2	72
Tibia-fibula	11	2	2	2				17
Humerus								
Radius-ulna	6	1				1	1	9
Total	66	16	2	6	3	2	3	98
	(67.4%)	(16.3%)	(2%)	(6.1%)	(3%)	(2%)	(3%)	(100%)

COMPOUND BATTLE FRACTURES

TABLE L
SUMMARY OF RESULTS IN ELECTIVE INDICATIONS
(67 Cases—22.3%)

All fixations were performed at the first operative procedure of reparative surgery when it was elected to use internal fixation as a means or adjuvant of maintaining fracture reduction in preference to other measures.

Code of Results	A	B	Bs	C	D	E	F	Total
Bone								
Femurs								
(all wire fixations)	2	4				1		7
Tibia-fibula								
(25 plate and 1 wire	6	7	6	1			6	26
fixations)								
Fibula fixations								
(all plates)	10	1				2		13
Humerus								
(6 plates, 6 screws								
and 9 wire fixations)	17	2		2				21
Radius-ulna								
Total	35	14	6	3		3	6	67
	(52.2%)	(20.8%)	(8.9%)	(4.5%)		(4.5%)	(8.9%)	(100%)

COMPOSITE RESULTS IN FIXATIONS FOR WHICH INDICATION HAS BEEN RECORDED

Code of Results	A	B	Bs	C	D	E	F	Total
Totals	174	52	8	21	6	14	25	300
	(58%)	(17.3%)	(2.7%)	(7%)	(2%)	(4.7%)	(8.3%)	(100%)
Group X	32							32
Grand total	206	52	8	21	6	14	25	332
	(62.1%)	(15.7%)	(2.4%)	(6.3%)	(1.8%)	(4.2%)	(7.5%)	(100%)

III—SUMMARY OF ALL RESULTS NOT CLASSED AS EXCELLENT (A) OR VERY SATISFACTORY (B)

(Except the Bs-group previously discussed)

TABLE M
C RESULTS—21 CASES

(The fractures are united but the wounds are unhealed)

Femur—11 cases.		Cases	Fixation
Indications—Obligate—(1, 2)—Bone loss and faulty reduction.....	1	1	Plate
Obligate—(1, 4)—Bone and soft tissue loss.....	1	1	Plate
Obligate—(2) —Faulty reduction.....	5	5	Plate
Desirable.....	4	4	Screws
		11	

Average time since wounding until observed (11 cases) was seven months.

In five cases the metal and sequestra remain. Eventual satisfactory results are anticipated after appropriate surgery.

In one case, only four months since wounding, the metal and sequestra were removed three days before he was seen. He will probably become a B result in two to three weeks.

In one case, an obligate-I, 4 indication, the soft-tissue loss was so massive that bone has been exposed since injury. Following plating, union has

occurred. The failure of wound healing is the result of the injury, not the fixation.

In four remaining cases, further sequestrectomies and plastic surgery may be required.

<i>Tibia-fibula</i> —5 cases.	Cases	Fixation
Indications—Obligate—(2).....	2	Screws
Desirable.....	2	Screws
Elective.....	1	Plate

Union of the fracture was delayed in three cases. Sequestration was massive in one case and heavy in two others. In these, reinforcing grafting may be necessary.

<i>Humerus</i> —5 cases.	Cases	Fixation
Indications—Obligate—(1) (bone loss).....	1	Wire
Obligate—(2) (faulty reduction).....	2	Plates
Elective.....	2	Wire
	<hr/> 5	

The one case of bone loss was a wire-loop fixation by which a 1.5-inch defect was overcome. Union alone in this case is an excellent achievement.

Radius-ulna—None.

Appraisal—Eventual satisfactory results after appropriate surgery.

TABLE N

D RESULTS—6 CASES

(The fractures united and the wounds healed after removal of sequestra and metal, but the time for each was prolonged appreciably)

<i>Femur</i> —5 cases. (All were plate fixations)	Cases
Indications—Obligate—(2) (faulty reduction).....	2
Desirable.....	3
	<hr/> 5

Average time from wounding until it could be verified that the fractures were united and wounds healed was nine months.

Tibia-fibula—None.

Humerus—1 case. (Plate fixation)

Indication—Obligate—4—a massive soft-tissue loss.

The union achieved is precarious. This case was a severe upper extremity injury with a massive septic wound of a compound fracture of the upper third of the radius and ulna which was also fixed internally, with a failure resulting.

Radius-ulna—None.

Appraisal—Unsatisfactory results but not complete failures. There are no comparable data available on nonfixation cases with which to compare this incidence.

COMPOUND BATTLE FRACTURES

TABLE O

E RESULTS—14 CASES

(The fractures did not unite but the wounds healed without sequestration or removal of metal)

Femur—5 cases.	Cases	Fixation
Indications—Obligate—(1) (bone loss).....	2 ^a	1 plate—1 wire
Obligate—(2) (faulty reduction).....	1 ^b	Plate
Desirable.....	1 ^c	Screw and wire
Elective.....	1 ^d	Wire
	—	
	5	

^a Nonunions were probably inevitable without the use of internal fixation.

^b A large rotated central fragment which could not be reduced (a double fracture). The proximal fracture united. The distal may go on to union. The internal fixation here was very advantageous.

^c A mildly comminuted fracture of femur which was only partially stabilized by screws and a wire-loop in the presence of sepsis (associated amputation of foot on same side and of leg on opposite side) is now only four months after injury. The fracture may unite.

^d A severely comminuted septic lower third fracture of the femur (a septic knee associated). Wire-loops were used to hold major fragments approximated and the fracture site was drained dependently. The nonunion which followed cannot be attributed to the internal fixation.

Tibia-fibula—I case.

Indication—Obligate-2 (faulty reduction). This case was plated with distraction as determined by the overseas roentgenograms. The nonunion can be attributed to this error in technic.

Tibia-fibula (fibula plated)—2 cases. See footnotes, Table B-2.

Humerus—4 cases.	Cases	Fixation
Indications—Obligate—(1) (bone loss).....	3 ^a	Wire
Obligate—(2) (faulty reduction).....	1 ^b	Plate

^a Union was obtained in ten similar cases by internal fixation (see above table).
^b Operation was 25 days after wounding and after the wound had healed.

Radius-ulna—2 cases.	Cases	Fixation
Indications—Obligate—(1) (bone loss).....	1 ^a	Wire
Desirable.....	1 ^b	Plate

^a A one-inch segmental defect in the radius with an intact ulna. A wire-loop was inserted to help maintain alignment, without hope of union.

^b A double fracture of the ulna and a fracture of the radius. A Steinman pin passed down the medullary canal of the ulna was removed after three weeks. The radius was plated. The ulna failed to unite at each fracture. Actually, poor reduction was obtained. The radius may yet unite.

Appraisal—Satisfactory insofar as the hazard of sequestration is concerned.

1. Improved by use of fixation.....	4
2. Unimproved but not retarded.....	9
3. Retarded?—(faulty technic).....	1 = 0.3% of 332 cases
	—
	14

TABLE P

F RESULTS—25 CASES

(Nonunion, with sequestration and without wound healing until, in five cases after removal of sequestra and metal, the wounds healed. Because this group are the "failures," each case is abstracted)

Femur—Nine cases.

Case 1 (Obligate—bone loss).—At reparative surgery on the eighth day after wounding a fracture of the lower third of the femur exhibited a large segmental defect

without contact of fragments. The surgeon's note stated that reduction could be maintained only by internal fixation so the femur was plated. There was further sequestration of approximately 1.5 inches of bone. Following removal of metal and sequestra, the wound healed. The fixation undoubtedly contributed to the sequestration and delayed wound healing but nonunion was inevitable without it.

Case 2 (Obligate—bone loss).—If amputation had been performed, it could not have been criticized as there was extensive bone and soft-tissue loss. Several wire loops were used to keep some of the larger fragments approximated. The result can be in no way attributed to the fixation.

Case 3—(Obligate—faulty reduction).—On the 32nd day after wounding, in the presence of sepsis and at surgery for a secondary hemorrhage, a faulty reduction of a subtrochanteric fracture was corrected. One large comminuted fragment was fixed by screws to the upper fragment and it united. The lower fragment was held approximated to the upper by a wire loop, but the contact was poor and the surgeon's note stated that he anticipated nonunion. The sequestra and metal have been removed in the Z. of I. At this time the wound is healed except for a raw area in the massive scar.

Case 4 (Obligate—faulty reduction).—On the 23rd day after wounding, a comminuted upper third of the femur was plated in reduction. Three months later metal and sequestra were removed. The extremity was placed in skin traction. Roentgenograms, one month and two months later, show progressive bowing, and for that reason this case is called a nonunion. He is now, six months after fixation, in a spica, and the fracture may unite. The wounds are about healed. It is difficult to compare the present result with what could have been anticipated without internal fixation.

Case 5 (Obligate—faulty reduction).—On the 28th day after wounding, in the presence of established sepsis, the femur was plated. A six-hole plate with only four screws and with one transfixion screw was the fixation. On postoperative roentgenologic examination, the fixation does not appear stable. The metal and sequestra were removed 2.5 months later in the Z. of I., after which the wound healed, but at this time (5.5 months since fixation) there is no union. The fixation here was of minimum benefit although it held position. It probably contributed to the sequestration.

Case 6 (Obligate—faulty reduction).—On the 17th day after wounding, through a septic wound, the comminuted fracture of the midshaft was plated in reduction. A study of the roentgenograms indicates that the fracture might have been reduced in traction. The result is considered a complete failure and the fixation probably contributed to it.

Case 7 (Obligate—faulty reduction).—On the 66th day after wounding, following a sepsis so severe that amputation was considered, the widely separated femoral fragments were plated, but the operative note states that stabilization was not achieved. The result would probably have been the same had the fixation not been performed.

Case 8 (A desirable).—On the sixth day after wounding, a midthird fracture was plated. Two months later, in the Z. of I., the plate and sequestra were removed, after which the wound healed. At this time, six months after fixation, there is no union. The result here is not good. Perhaps the metal was removed prematurely.

Case 9 (A desirable).—On the seventh day after wounding, a midthird fracture was plated. The metal and sequestra were removed three months later in the Z. of I. At this time, six months after fixation, the extremity is in traction. Only a small sinus remains and it is thought that the fracture is uniting. An optimistic evaluation would have placed this case as a D result, delayed. However, the result is not satisfactory.

Tibia-fibula—Nine cases.

Case 1 (Obligate—faulty reduction).—A double fracture was plated. The proximal only united. Sequestra and metal were removed.

Case 2 (Elective).—A wire loop was probably of benefit. The fragments are in excellent approximation and, as it is only four months since wounding, union is expected.

COMPOUND BATTLE FRACTURES

Case 3 (Elective).—Only three months have elapsed since wounding, but sequestra and a plate have been removed. Union may occur.

Cases 4-9 (Four electives and two obligates—one for bone loss, one for faulty reduction). *All were plate fixations.* The sequestration was massive, wound healing is not achieved, and the resultant scar will be excessive. These are failures in every sense and the surgery contributed directly to the prolonged disability. Bridging bone grafts will be necessary in several.

Humerus—Four cases.

Case 1 (Obligate—bone loss).—A wire loop fixation.

Case 2 (Obligate—massive soft-tissue loss).—A plating.

Cases 3-4 (Obligate—bone and soft-tissue loss).—These were platings. Sequestration was not severe.

All were probably doomed to nonunion regardless of the fixation.

Radius-ulna—Three cases. (All fixations were platings.)

Case 1 (Obligate—soft-tissue loss plus faulty reduction).—Also had a severe fractured humerus which was fixed with a D result, as described above. The ulna was plated 39 days after wounding, in the presence of established sepsis, because the reduction was poor and the soft-tissue wound demanded repeated staged procedures. Neither the bone nor the metal could be covered by soft parts. The result to date cannot be attributed to the fixation but any periosteal stripping that was done may have contributed to the sequestration.

Case 2 (Obligate—massive soft-tissue loss).—A plating of a radius with a concurrent massive loss of ulna. Union did not occur and there was some sequestration.

Case 3 (Desirable).—A plating of a double fracture of the radius with some soft-tissue loss. Neither bone nor wound healing occurred. The indication here was almost an obligate.

Appraisal: Failures with qualifications.

1. Improved by fixation	2
2. Unimproved but <i>not</i> retarded	8
3. Retarded	13 = 3.9 per cent of 332 cases
4. Not classifiable at this time.....	2
	—
	25

ADDITIONAL OBSERVATIONS AND DATA

1. Results in Fixation Performed in the Recorded Presence of Established Wound Sepsis.

Code of Results	A	B	Bs	C	D	E	F	Total
Bone								
Femurs	9	3		1	2	2	4	21
Tibia-fibula			1	1			1	3 ^b
Humerus	1			1		1		3
Radius-ulna		1					1	2
	10	4	1	3	2	3	6 ^a	29
	(35%)	(14%)	(3.5%)	(10.5%)	(7%)	(10.5%)	(21%)	(100%)

^a The average time from wounding to fixation in this group was 36 days.

^b This figure is probably too low.

2. *Recorded Associated Nerve Trunk Injury.*

Bone	No. of Fractures	No. of Nerve Injuries Recorded	Per Cent
Femur	135	9	6.6
Tibia-fibula	75	1*	1.3
Humerus	63	21	33.3
Radius-ulna	26	6	23.1

* Nerve injuries in the leg often are not recorded, so this figure is probably too low.

3. There were *no deaths nor amputations* in these cases nor was either reported by the hospitals visited in a patient from M. T. O., or other theaters, upon whom a delayed internal fixation of a compound fracture had been performed.

4. *Refracture* occurred *seven* times, and in fractures of the femur only. The refractures were at points of bone loss from injury, not from sequestration except in one B result which is covered in footnote above. One additional case was a B result, the other five were A.

5. In every case, but two, from which metal was removed before wound healing, sequestra were found and removed.

OBSERVATIONS UNSUPPORTED BY DATA

1. Knee motion was excellent in some of the fixed fractures of the upper half of the femur, but infrequently so in fractures of the lower third. Lower third and anterior wounds prejudice the return of knee motion. It is thought that the range of knee motion following rigid internal fixation, and following a program designed to achieve the maximum return, exceeds that which is seen in comparable cases managed by other measures. The fixations have not been followed always by a knee motion program. Failures to do so is by-passing one of the advantages of the method.

2. Wound healing without sequestration and without removal of the metal is favored by fixations through separate incisions particularly if the fixation is to be a plating.

3. Failure of wound healing has been prolonged in some cases because removal of sequestra and metal was delayed even though the fracture was well united.

4. Inadequate reduction of several fractures of the femoral shaft (Case 19) and of other long bones treated by nonfixation measures, with varying degrees of malunion and sometimes delayed union, were observed. The contour of many of these fractures on roentgenologic examination suggested that internal fixation would have been feasible, a procedure which, it is believed, would have improved the end-results. Nonunions of humeri with segmental defects were seen repeatedly in which union might have been achieved by maintaining bony apposition with metallic fixation (Case 20).

CONCLUSIONS

1. There is a definite place for the use of delayed internal fixation in battle fractures in the fixed installations of the Communications Zone.

2. Its use should be as an adjuvant to fracture management under the principles previously expounded for reparative surgery of compound fractures, *i.e.*, excision of residual dead tissue including totally detached fragments, minimal periosteal stripping, closure of wounds to cover denuded cortex of bone with vascular soft parts, and dependent drainage of residual dead space. Failure to provide the measures which prevent sepsis and favor wound healing will prejudice the procedure.

3. The results achieved in this group of cases are deemed very satisfactory *with the exception of those in the plated fractures of the tibia and fibula and those associated with massive soft-tissue loss (Obligate-4)* particularly when they are evaluated in the light of their adjudged indications. Because no comparable data are available on similar groups of battle fractures managed without the use of delayed metallic fixation, it is impossible to establish a control with which to compare these results.

4. In the light of the results achieved in this series it seems reasonable to state that by the use of delayed internal fixation:

a. Nonunions in fractures with segmental defects or persistent distraction may be prevented in many cases, as is evidenced by the achievement of bony union in 27 (69%) of 39 cases in this series.

b. Varying degrees of malunion or, perhaps in some cases, delayed or nonunion, in fractures in which inadequate reduction was achieved by other measures, may be prevented in many cases, as is evidenced by the achievement of bony union in good apposition and alignment in 64 (85%) of 75 cases in this series.

c. Bony union in the optimal reduction of condylar fractures about the knee and elbow may be achieved, as is evidenced in 100% of 15 cases in this series.

d. The obvious advantages of well-stabilized maximum reduction of fractures which lend themselves to rigid stabilization and satisfactory wound healing may be achieved in many cases providing the fixation is performed by multiple screws with minimal periosteal stripping, as is evidenced by union in good position in 94 (98%), and wound healing without sequestration or removal of metal in 71 (74.7%), and in another 14 (14.9%) after their removal in a total of 95 cases.

If plating is the method of fixation bony union and satisfactory wound healing may be anticipated in a smaller percentage of cases, as is evidenced by union in 140 (84.3%), and wound healing without sequestration or removal of metal in 99 (59%), and *readily* in another 34 (20.3%) after their removal in a total of 168 cases.

e. Improved apposition of fragments may sometimes be provided by the use of wire loops, with anticipated favorable results in many cases, as is evidenced by the achievement of bony union in 59 (85.5%), and of wound healing without sequestration or removal of metal in 50 (72.5%), and in another 12 (17.4%) after their removal in a total of 69 cases regardless of other qualifying factors.

5. The hazard of delayed internal fixation appears to be increased sequestration, which may be explained by the periosteal stripping which the procedure entails and by its interference with readherence of soft parts to denuded bone. Other observations indicate that sequestration of bone in nonfixed battle fractures is limited practically always to bone that probably was denuded at wounding. Sequestration occurred in 34.3% of cases in this series, but, again, comparable data for a control are not available. From the estimated degree of sequestration observed in this series it seems reasonable to state that with:

a. Screw or wire fixation, sequestration is seldom massive, does not seem to interfere with union of the fracture, and probably would have occurred in many cases had nonfixation measures been employed.

b. Plating, followed by sequestration in 41% of 168 cases, is sometimes followed by massive sequestration and retardation of the attainment of full strength of the bone. It may create a massive defect reparable only by bone grafting.

6. a. Unless the fracture contour permits a rigid fixation by screws or unless wire loops appear advantageous, it is preferable to attempt reduction by traction or manipulation and strive for early wound healing. Following wound healing, fixation by plating or other fixation is relatively nonhazardous, as is evidenced by wound healing in 95% of 21 cases in this series without sequestration or removal of metal.

b. Fixations of the long bones of the upper extremity may be expected to give excellent results if the severity of bone loss or of the soft tissue injury does not prejudice the chances of union and wound healing. Of the seven F results (failures) in the upper extremity, five had massive soft-tissue loss and the other had bone loss.

c. Fixations of the femur performed on indications, utilizing multiple screws or wire loops and with minimal periosteal stripping may be expected to give excellent results. In the femur, there were no F results with screws, and the two F wire-loop fixations were bone loss cases, one of which had a massive soft-tissue loss. The hazard of periosteal stripping required for plating makes it preferable that plating be delayed until after wound healing unless the indications and anticipated advantages overshadow the hazard.

d. Fixations of the tibia by multiple screws or wire loops may be expected to give very satisfactory results. Periosteal stripping for the fixation should be minimized. Only the two Bs results—(heavy sequestration)—were unfavorable among those fixed by screws. The only unfavorable wire loop fixation (an F result) is only four months since wounding and is expected to unite. *Plating* of the tibia should be reserved until after wound healing. In the tibia, eight of the nine failures and six of the eight massive sequestrations were plate fixations. A greater use of wire loops to maintain approximation only may offer improved results.

e. The plating of the fibula in a fracture of both bones may be a useful procedure which is relatively nonhazardous. It maintains length and align-

ment, aids in achieving apposition of tibial fragments and provides some degree of immobilization of the fracture of the tibia.

7. Internal fixation as an adjuvant to the management of the unreduced septic compound battle fracture may aid in the control of sepsis and in achieving the maximum obtainable result (Cases 3, 4, 5 and 8). In 29 cases in this series bony union was achieved in *good alignment* in 20 (69 per cent), wound healing without further sequestration in 13 (45.5 per cent), and, after removal of sequestrums and metal, in 13 (17.5 per cent) additional.

8. The indications for delayed internal fixation can be defined only for those instances in the management of the wounded *when the advantages offered by maximum fracture reduction and (usually) stabilization are not overshadowed by other considerations*. With this qualification, it may be stated that the indications for the use of delayed internal fixation in the Base Hospital either at the initial operation of reparative surgery or later are*:

A—Obligate:

- (1) Segmental defects or persistent distraction of fragments.
- (2) Inadequate reduction by other measures.
- (3) Displaced condylar fractures.
- (4) Associated nerve surgery which can be facilitated greatly by the fixation.

B—Desirable (Advantageous):

- (1) Fractures of the long bones (especially the femur) the contour of which permits rigid stabilization by multiple screws with minimum periosteal stripping.
- (2) Fractures in which nonrigid fixation by wire loops will provide a degree of fracture reduction probably not attainable without it.

9. Further study of this problem, and a comparable study of fractures managed by nonfixation measures, definitely are indicated. Each case should be evaluated in the light of the problem confronting the overseas surgeon and the anticipated result by fixation and nonfixation measures.

SUMMARY

Thus, a follow-up study of 332 compound fractures (all but 13 were missile fractures) which were fixed internally as an adjuvant to fracture man-

*In an evaluation of the indications, it must be understood that the principles of reparative surgery of compound fractures call for thorough wound visualization including the fracture site by gentle retraction of the wound edges at the initial operation of reparative surgery, usually five to ten days after wounding. Indicated excisional surgery is performed, the fracture site cleaned and visualized. It is then that the decision to use internal fixation is made in some instances, *e.g.*, loss of bone with segmental defect, displaced condylar fracture, oblique fracture of a shaft of bone which may be fixed in reduction with minimal additional periosteal stripping. In these cases, an additional anesthesia and operation are not required. An additional operation is necessary only in those cases where reduction by other measures has not been adequate or as an adjunct to nerve surgery.

agement in the Base Hospitals of the Mediterranean Theater of Operations reveals that in 258 (77.2 per cent) cases classed as A or B, the maximum achievable result has been obtained. The eight cases of fractures of the tibia in which sequestration was massive are not good results, but, in the end, an excellent weight-bearing extremity is anticipated. The 21 fractures classed as C results should become, after appropriate surgery, satisfactory end-results. Of the 14 nonunions, the E results, in only one was union retarded by the fixation, and that was an inferior technical job. The results in the 25 F's (or Failures) showed retardation in only 13 cases. Approximately 70 per cent of the fixations were performed at the initial operation of reparative surgery between five and 15 days after wounding, either through the compounding wound or a separate incision. The wounds were healed prior to the fixation in only 21 cases. The surgery was performed in 18 hospitals by approximately 50 surgeons of varying prewar civilian experience who had studied, and were experienced in the problems of wound and fracture management in reparative surgery of war wounds. From the conclusions which this study allows, the incidence of unfavorable results in a similar group managed under the same principles should be reduced to a minimum. A place for the delayed internal fixation of battle fractures has been established.

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(To be continued in February issue)

THE INCIDENCE OF COMPLICATIONS IN THE USE OF TRANSFIXION PINS AND WIRES FOR SKELETAL TRACTION

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THE INCREASE in the number of severe fractures of the long bones during war provides an unusual opportunity for comparing the safety and reliability of various methods of fracture treatment. Recent personal communications from other Theaters of Operations and from the Zone of Interior indicate that enthusiasm for the use of transfixion pins and wires for skeletal traction has been considerably dampened by the high incidence of complications, principally osteomyelitis and chronic draining sinuses, which has followed their use. This has led some surgeons to prefer skin traction to skeletal traction, even though in many instances less satisfactory reduction and fixation of the fragments can be obtained. Some are even said to believe that the risk of infection in open operation is not appreciably greater than in skeletal traction.

At a General Hospital in India, 342 transfixion pins and wires (195 Kirschner wires, 95 Steinmann pins, and 52 Roger Anderson pins) have been used in treating fractures of the long bones during the past two years. Because of the experiences related by others, the complications encountered in using this method of fracture treatment at this hospital have been reviewed. In caring for a large number of Chinese patients, in whom treatment was necessarily carried to completion before disposition, we have had an opportunity, believed to be unusual in Army Hospitals overseas, to observe the majority of these pins and wires during the entire period of their use.

TYPES OF FRACTURES AND METHODS OF TREATMENT

During the two-year period from April 1, 1943, to April 1, 1945, 342 transfixion pins and wires were used in the treatment of 233 fractures of the long bones. The fractures treated, the type and site of transfixion; the relative frequency of fixed and balanced traction; the average number of weeks of transfixion; the percentage receiving a prophylactic oral sulfonamide; and the complications are shown in Table I.

Complete fractures of the femoral shaft requiring reduction were routinely treated by balanced skeletal traction-suspension, with a Kirschner wire inserted through the tibia at the level of the tubercle or through the femur at the junction of the shaft and condyles. Transfixion pins or wires were used in treating fractures of the tibia, humerus, and forearm only in instances in which more conservative methods were inadequate for reducing the fracture or maintaining good position of the fragments.

All of the pins and wires were inserted at this hospital, using rigid aseptic

technic. In most instances, this procedure was carried out in the operating room. If it were avoidable, pins or wires were not inserted through an hematoma or within three or four inches of the wound of a compound fracture, even though insertion there would have been preferable for reduction of the fracture.

TABLE I

ANALYSIS OF THE USE OF 342 TRANSFIXION PINS AND WIRES IN TREATING 233 FRACTURES OF THE LONG BONES

Fracture	Type of Transfixion				Site of Transfixion				Average Number of Weeks of Transfixion	Percent age of Receiving Prophylactic Sulfonamide	Complications			
	Kirschner Wire	Steinmann Pin	Roger Anderson Pin	Olecranon	Distal Radius and Ulna	Femur	Tibia	Os Calcis						
Femur:									Balanced Traction	Fixed Traction				
Comp. 120													Infection	0
Simp. 47	173	1	28			114	87	1	190	12	9.1	57.8	Broken K. wire	1
													Loose K wire	3
													Yoke slipped	1
Total 167													Loose R.A. pins	2
Tibia:													Infection	1
Comp. 28														
Simp. 21	13	70					59	24	18	65	4.8	66.0	Transient peroneal palsy	2
Total 49														
Humerus:													Infection	0
Comp. 3														
Simp. 4	7			7					7		6.0	57.0	Loose wire	1
Total 7														
Forearm:													Infection	0
Comp. 15														
Simp. 5	2	24	24	23	27				14	36	6.8	66.0	Loose R.A. pin	1
Total 20														

Of the 342 pins and wires, 305 were observed during the entire period of their use and were removed at this hospital. In all but one the pin and wire holes healed promptly. The final result of only 37 transfixions is unknown. Seventeen of the pins and wires have not yet been removed and have not, during an average observation period of six weeks, shown any evidence of complications. The remaining 20 (Steinmann pins) were still incorporated in plaster when the patients were dispositioned to the Zone of Interior, and the final result cannot be stated, but no complication had been observed on disposition after an average period of 5.2 weeks.

COMPLICATIONS

Although there were no complications noted in the 37 transfixions in which the final result is unknown, this group has not been included in computing the incidence of complications. In the group of 305 transfixions in which the final result is known, complications occurred in 12, an incidence of 3.93 per cent. Four Kirschner wires became loose in bone, one wire broke,

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and in one instance the Kirschner bow slipped from one end of the wire, allowing traction to pull the wire out of the bone. Steinmann pins caused one infection and two transient peroneal nerve palsies, and three Roger Anderson pins became loose. The relative frequency of these complications is shown in Table II, with a brief descriptive comment about each.

TABLE II
ANALYSIS OF COMPLICATIONS OF 305 TRANSFIXIONS

Type of Transfixion	Complication	No.	Per Cent	Comment
Kirschner wire 186	Loose wire	4	2.15	Compound fracture femur. Wire through tibial tubercle became loose at 8 weeks. Probably due to too superficial insertion. Wire hole healed promptly. Not necessary to renew traction because of adequate bone union. Simple fracture femur. Wire through tibial tubercle pulled through into soft tissue at 6 weeks. Wounds healed promptly. Union sufficiently strong to permit discontinuance of traction. Simple fracture humerus in a psychotic patient. Constant manipulation of the yoke by the patient loosened the wire inserted through the olecranon within two weeks. Wire hole healed promptly on removal. Subsequent treatment with "hanging cast." Good result. Simple fracture femur. Wire through tibial tubercle became loose at 8 weeks. Probably due to too superficial insertion. Wire hole healed promptly. Not necessary to renew traction because of bone union.
	Broken wire	1	0.54	Compound fracture femur. Wire through distal femur broke at 14 weeks. Not necessary to renew traction because of adequate bone union. Wire hole healed promptly.
	Bow slipped	1	0.54	Compound fracture femur. Wire through distal femur slipped out of one end of bow and was pulled out of bone at 8 weeks. Not necessary to renew traction because of adequate bone union.
Steinmann pin 67	Infection	1	1.49	Simple fracture tibia transfixed with two Steinmann pins. Abscess about medial pin hole of distal pin at 4 weeks due to severe pyogenic folliculitis beneath encasement. Pin removed, abscess drained. Complete healing of wounds within 10 days. Healing of fracture not affected.
	Transient peroneal palsy	2	2.98	Compound fracture tibia. Partial peroneal palsy immediately following insertion of Steinmann pin through upper tibia. Due to faulty insertion, beginning on medial side. Palsy had disappeared before pins were removed at 6 weeks. Simple fracture tibia. Peroneal palsy discovered 2 weeks after insertion of pin in proximal tibia. Palsy had almost disappeared when pins were removed at 6 weeks.
Roger Anderson pin 52	Loose pin	3	5.77	Simple fracture radius and ulna. One pin found to be loose at completion of treatment, 10 weeks. Simple fracture femur. One pin found to be loose at completion of treatment, 10 weeks. Simple fracture femur. One pin found to be loose at completion of treatment, 10 weeks.

In 11 of these instances the complications were probably avoidable. Four loose Kirschner wires and three loose Roger Anderson pins were apparently due to improper insertion—too superficial insertion in the case of the Kirschner wires, and failure to engage both cortices in the case of the Roger Anderson pins; or to excessive manipulation of the traction apparatus by the patient in certain Chinese and in one psychotic patient. It may be assumed that the wire which broke and the bow which slipped were defective. The two peroneal nerve palsies, resulting from the insertion of Steinmann pins

through the upper tibia, were due to the faulty technic of beginning the insertion on the medial surface. If landmarks are carefully palpated and insertion is begun on the lateral surface, the tibia may readily be transfixed at an adequate depth without endangering the peroneal nerve. Insertion begun on the medial surface may injure the nerve if the point of insertion is too far posterior or there is posterior deviation of the pin.

A small amount of drainage from the pin or wire holes, at some time during the course of transfixion or for one or two days following removal, has not been uncommon. Not infrequently the drainage has appeared grossly to be purulent but, because of the absence of local and general signs of inflammation and the prompt healing following removal of the pins or wires, this has not been regarded as infection. Infection occurred in only one instance about a Steinmann pin inserted through the lower tibia, and probably could not have been avoided. Severe pyogenic folliculitis due to occlusion by the plaster encasement (which in our experience has been infrequent) developed, and was almost certainly the source of the infection. Following incision and drainage of an abscess which formed about the medial entrance of the pin four weeks after insertion, the drainage incisions and the pin holes healed within ten days and, at present, four weeks later, no evidence of renewed inflammation or drainage has appeared. There has been no roentgenographic evidence of osteomyelitis about the pin hole. Since this infection occurred just prior to the time planned for removal of the pins, when adequate callus was present, the course of treatment was not altered.

It is to be noted in Table II that in this single instance of infection, and in the 11 other instances in which complications occurred, the course of treatment and the final result were not significantly affected.

Prophylactic oral sulfonamides were administered in approximately 60 per cent of the patients, either because the fracture was compound or because of associated injury or disease. No infection occurred in the group. Since only one infection occurred in the 40 per cent not receiving sulfonamides, and it is not at all certain that a sulfonamide would have prevented this infection, there is no statistical evidence that prophylactic sulfonamides played a part in preventing infection at the pin site in this series. In no instance was a prophylactic sulfonamide used for the sole purpose of preventing infection at the pin site.

SUMMARY

1. Three hundred and forty-two pins and wires were used to transfix bone for skeletal traction in the treatment of 233 fractures of the long bones.
2. In the 305 transfixions in which the final result is known complications occurred in 12, an incidence of 3.93 per cent.
3. Infection at the pin site occurred once, an incidence of 0.33 per cent. This infection is believed to have been unavoidable. Osteomyelitis and a chronic draining sinus did not result.

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4. Other complications, all of which are considered avoidable, were:
 - a. Loosening of four Kirschner wires.
 - b. Loosening of three Roger Anderson pins.
 - c. Two transient peroneal nerve palsies.
 - d. Breaking of one Kirschner wire.
 - e. Slipping of one Kirschner wire bow.
5. In no case did a complication have any significant effect upon the course of treatment or the final result.

CONCLUSION

In our experience the use of transfixion pins and wires for skeletal traction has been a safe and reliable procedure. Complications have been infrequent and benign.

ABDOMINAL SURGERY IN AN EVACUATION HOSPITAL

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THE SEPARATE EVACUATION HOSPITALS in the European Theater of Operations have had a varying relationship to front line activity made necessary, first, by the small area which the American Forces held early in the Normandy Campaign, and, later, by the rapid drive of the Armies from Normandy across France and Belgium to the German border. The location of our own hospital unit has varied from four to 30 miles behind the active fighting front. During certain periods we functioned forward of the Field Hospitals and Clearing Companies, but for the most part we were situated behind these units. The type of cases we received varied with our location. During the long periods when we were a well-advanced installation forward of the Field Hospitals we received a larger percentage of patients with abdominal injuries. These patients, classified as nontransportable, otherwise might not have reached our hospital.

From the middle of June, 1944, to the end of December, 1944, five per cent of the total battle casualties received had abdominal injuries. This series of 341 patients includes all those with penetrating and perforating wounds involving the peritoneum. In addition, we have included those cases of severe retroperitoneal hemorrhage from injuries to the large vessels, such as the vena cava, and from injury to the kidneys, because such cases frequently necessitated exploratory celiotomy to determine the full extent of the injury. Also included in the series is a group of cases of perforating wounds of the rectum. All of these cases had inguinal colostomy performed as part of their treatment. We have excluded from our series all those cases which had been operated upon prior to their admission to our own hospital.

For clarification we have established the following classification: First, combined thoraco-abdominal wounds involving perforation of the diaphragm and due to a single missile. Second, combined thoraco-abdominal wounds due to two or more missiles and not involving perforation of the diaphragm. Third, abdominal wounds not associated with chest injuries (Table I).

We believe this series of abdominal war injuries is the largest which has thus far been presented by a single hospital unit. On the basis of this experience, there are certain facts which we can present and other clear-cut impressions which we can offer.

The diagnosis of intra-abdominal perforation is usually obvious in most battle casualties. However, when the location of the entrance and exit wounds are far removed from the abdominal area the diagnosis may be very difficult. The diagnosis of intra-abdominal injury should be determined by

history, physical examination, and roentgenologic examination. Some patients show no abdominal rigidity and little abdominal tenderness, especially those patients in shock or impending shock. These patients may have physical signs of peritoneal irritation only after they have recovered from the shock state. Patients with small perforations of the descending and sigmoid colons occasionally show signs of peritoneal irritation late. Shoulder pain is not an outstanding symptom. Auscultation of the abdomen will usually reveal a silent abdomen when peritoneal irritation is present. Absence of liver dullness is often present but is not a constant finding in gastro-intestinal perforations. The location of the foreign body roentgenologically may determine the diagnosis. Proctoscopy and sigmoidoscopy have been invaluable in uncovering perforating wounds of the rectum and sigmoid colon. A total of 305 patients with buttock, perineal, or upper thigh wounds were proctoscoped and sigmoidoscoped. Perforations of the lower colon and rectum were visualized in 34 cases. Catheterization and uranalysis may be the determining factors in exposing wounds of the urinary tract. Uanalysis is carried out in all suspected abdominal injuries. Aspiration of gastric contents through a Levin tube may reveal evidence of injury to the stomach. In some cases only exploration of the wound or celiotomy will reveal the intra-abdominal injuries.

The preoperative management of the battle casualty with intra-abdominal injury may be the decisive factor in the ultimate outcome. All battle casualties suspected of having intra-abdominal injuries were sent directly to a special shock ward for examination and observation even though there was no evidence of shock at the time of admission to the hospital. The absence of shock in patients even with severe abdominal wounds is not an unusual finding.

Complete physical examination of the patient should be accomplished before intravenous therapy is instituted. Treatment for shock is immediately instituted with transfusions of whole blood and plasma in an effort to increase the blood pressure, improve the general condition of the patient, and to prepare for operation. In patients in whom active intra-abdominal bleeding is suspected operation is performed immediately and the blood transfusion is continued during the operation.

It has been our experience that whole blood rather than plasma should be used in combating the severe shock due to intra-abdominal injuries. It usually requires one or more liters of whole blood to bring the patient out of the shock state and to satisfactory condition for operation. Most patients will show definite response to this therapy within one to two hours unless active bleeding persists or the state of "irreversible shock" is present. The general appearance of the patient and the skin warmth are valuable criteria of response to therapy. Repeated blood pressure readings are important but any single reading in itself may be misleading. Dehydration in a patient should be treated by intravenous isotonic dextrose solutions. Plasma itself has only very limited use in the preoperative management of patients with abdominal injuries.

Patients with evisceration of the intra-abdominal organs require early surgery. These patients are usually in moderate or severe shock and do not respond to the usual forms of shock therapy. It is only when the eviscerated organs are replaced by operation that these patients show improvement. In our series of cases, we have had 16 patients with evisceration. Ten of these (63.8 per cent) died. Three of those who recovered had evisceration of omentum only. Excluding these the mortality rate was 76.9 per cent. Patients with herniation of viscera through a wound in the diaphragm also require urgent surgery since they do not respond to shock therapy until the operative repair has been accomplished.

TABLE I

TABULATION OF ABDOMINAL INJURIES

A. PATIENTS WITH COMBINED THORACIC AND ABDOMINAL INJURIES CAUSED BY A SINGLE MISSILE. ALL OF THESE PATIENTS HAD PERFORATING WOUNDS OF DIAPHRAGM AND PLEURA

Type of Case	No of Cases	Deaths	Operated	Died Without Operation	Operative Mortality %	Over-All Mortality %
Esophagus.....	(a) 2	0	2	0	0	0
Stomach.....	3	(b) 2	2	1	50.	66.6
Stomach, small intestine & liver.....	1	1	0	1	0	100.
Stomach, transverse colon, spleen, with evisceration.....	2	(c) 2	1	1	100.	100.
Stomach, transverse colon and liver..	2	2	2	0	100.	100.
Stomach, transverse colon and small intestine.....	1	1	1	0	100.	100.
Stomach, descending colon and liver.	1	1	1	0	100.	100.
Stomach, liver and spleen.....	4	3	3	1	66.	75.
Small intestine.....	1	0	1	0	0	0
Small intestine, descending colon and kidney.....	1	0	1	0	0	0
Transverse ascending colon and liver	1	1	1	0	100.	100.
Transverse colon.....	1	0	1	0	0	0
Transverse colon and spleen.....	1	0	1	0	0	0
Descending colon.....	1	1	0	1	0	100.
Omentum, evisceration of small bowel	1	1	1	0	100.	100.
Peritoneum.....	11	(d) 3	11	0	27.3	27.3
Spleen.....	13	2	12	1	8.3	15.4
Liver.....	23	(e) 3	23	0	13.0	13.0
Liver and gallbladder.....	1	0	1	0	0	0
Liver and kidney.....	4	4	2	2	100.	100.
Kidney, with herniation into pleural space.....	1	1	1	0	100.	100.
Stomach and spleen.....	4	1	4	0	25.	25.
Stomach and liver.....	2	1	2	0	50.	50.
Total.....	82	30	74	8	29.7	36.6

B. PATIENTS WITH CHEST AND ABDOMINAL INJURIES CAUSED BY MULTIPLE MISSILES. THESE PATIENTS HAD HEMOTHORAX, BUT NO WOUND OF DIAPHRAGM

Small intestine.....	1	1	0	1	0	100.
Small intestine and descending colon.	1	0	1	0	0	0
Transverse colon.....	1	0	1	0	0	0
Ascending colon and kidney.....	1	1	1	0	100.	100.
Retroperitoneal space.....	1	1	1	0	100.	100.
Kidney.....	1	0	1	0	0	0
Perineum and genitalia, with colostomy and suprapubic cystostomy....	1	0	1	0	0	0
Transverse colon, descending colon and kidney.....	1	1	1	0	100.	100.
Total.....	8	4	7	1	42.8	50.
A & B totals.....	90	34	81	9	30.9	37.8

TABLE I (Continued)
TABULATION OF ABDOMINAL INJURIES

Type of Case	No. of Cases	Deaths	Operated	Died Without Operation	Operative Mortality %	Over-All Mortality %
C. ABDOMINAL INJURIES NOT COMPLICATED BY CHEST INJURIES						
Stomach.....	3	1	2	1	0	33.3
Stomach, duodenum and liver.....	1	0	1	0	0	0
Stomach, duodenum and transverse colon.....	1	0	1	0	0	0
Stomach, duodenum and small intestine.....	1	0	1	0	0	0
Stomach, small intestine and transverse colon.....	1	0	1	0	0	0
Stomach and transverse colon.....	1	0	1	0	0	0
Stomach, small intestine, transverse colon and liver.....	1	1	1	0	100.	100.
Stomach, liver, kidney and pancreas.....	1	1	1	0	100.	100.
Duodenum.....	1	0	1	0	0	0
Duodenum, small intestine.....	1	0	1	0	0	0
Duodenum and descending colon.....	1	1	1	0	100.	100.
Small intestine.....	39	(f-s) 8	37	2	16.2	20.5
Small intestine and ascending colon.....	7	5	(g) 5	(h) 2	60.	71.4
Small intestine, ascending and descending colon.....	4	2	(i) 3	(j) 1	33.3	50.
Small intestine and transverse colon.....	6	(g) 4	6	0	66.6	66.6
Small intestine and descending colon.....	13	4	10	3	10.	30.8
Stomach, spleen.....	1	0	1	0	0	0
Small intestine, transverse colon and spleen.....	1	0	1	0	0	0
Small intestine, descending colon, rectum and urinary bladder.....	5	4	5	0	80.	80.
Small intestine, extraperitoneal rectum.....	4	0	4	0	0	0
Ascending colon.....	11	1	11	0	8.3	8.3
Ascending colon and liver.....	1	0	1	0	0	0
Transverse colon.....	2	0	2	0	0	0
Transverse colon, small intestine, liver, evisceration.....	1	1	1	0	100.	100.
Transverse colon and liver.....	1	0	1	0	0	0
Descending colon.....	19	(l) 5	19	0	26.3	26.3
Descending colon, liver.....	2	1	1	1	0	50.
Descending colon, bladder.....	1	0	1	0	0	0
Descending colon, kidney.....	1	0	1	0	0	0
Extraperitoneal rectum.....	23	(m) 1	23	0	4.3	4.3
Extraperitoneal rectum and urinary bladder.....	1	0	1	0	0	0
Gallbladder.....	1	0	1	0	0	0
Gallbladder, liver and kidney.....	1	0	1	0	0	0
Spleen.....	5	0	5	0	0	0
Liver.....	8	2	5	1	20.	25.
Liver and kidney.....	4	0	4	0	0	0
Liver and small intestine.....	2	0	2	0	0	0
Retroperitoneal space, with hemorrhage.....	16	(e) 3	14	2	7.1	18.1
Mesentery, omentum.....	8	1	7	1	0	12.5
Peritoneum.....	14	(r) 1	12	0	8.3	7.1
Peritoneum, kidney.....	1	1	1	0	100.	100.
Kidney.....	7	3	(e) 6	1	33.3	42.9
Urinary bladder.....	4	1	4	0	25.	25.
Perineum and cystotomy.....	2	0	2	0	0	0

TABLE I (Continued)
TABULATION OF ABDOMINAL INJURIES

Type of Case	No. of Cases	Deaths	Operated	Died Without Operation	Operative Mortality %	Over-All Mortality %
Blast injury, with gangrene.....	2	(p) 1	2	0	50.	50.
Exact diagnosis unknown.....	(q) 1	1	0	1	0	100.
Subtotal.....	232	54	212	16	17.9	23.3
Negative explorations.....	19	0	19	0	0	0
Total.....	251	54	231	16	16.4	21.5
Grand total.....	341	88	312	25	20.2	25.5

NOTE: Twenty-five patients died without operation. The length of time they were in the hospital varied from 5 minutes to 12 days. The patient that died after 12 days was admitted with diffuse peritonitis and a traumatic ileostomy. He was treated expectantly. One patient died after 40 hours, who had fulminating peritonitis on admission. Eighteen, or 72% of these patient were in the hospital 5 hours, or less; 13, or 52%, 4 hours, or less; 11, or 44%, 3 hours, or less; 10, or 40%, 2 hours, or less; and 7, or 28%, one hour, or less.

- (a) One also had a wound of the spleen.
- (b) Also had brain injury.
- (c) One had a severed renal artery and vein.
- (d) Had large diaphragmatic hernia.
- (e) One also had a perforated vena cava.
- (f) The two that were not operated upon had peritonitis on admission, and one had a severed inferior mesenteric artery. Two that were operated upon had eviscerations. One had a perforated vena cava plus evisceration.
- (g) One also had a severed external iliac artery.
- (h) One had a severed ileocolic artery. One had evisceration six hours old.
- (i) One also had evisceration seven hours old.
- (j) Also had FCC femur.
- (l) Two had severed internal iliac arteries.
- (m) Had gas gangrene infection; also brain injury.
- (o) One had a perforated vena cava, one had a severed internal iliac artery, one had a severed common iliac artery.
- (p) Also had traumatic amputation both thighs.
- (q) Patient was a Belgian civilian; no autopsy done.
- (r) Died with pulmonary embolism. Had associated extremity wounds.
- (s) One also had traumatic amputation of left arm; died with hypostatic pneumonia, age 78. One also had a fractured pelvis; died with bronchopneumonia, age 80. One also had traumatic amputation of leg and multiple less severe injuries.

Our experience has shown that the time interval before operation is not the most important factor in determining mortality rates unless there is evidence of continued internal bleeding or evisceration. We have had good results with some patients operated on over 36 hours after injury. Our policy has been to restore these patients to the best possible condition prior to operation regardless of the length of time that has elapsed between the time of injury and the time of admission. Usually a patient with a blood pressure of below 80 systolic will not tolerate major surgery. However, we have seen some patients who despite the usually adequate shock therapy, do not respond by increased blood pressure. We feel that these patients, too, deserve the benefit of surgery even though the prognosis is not hopeful for their surviving the operative procedure. Of our 63 post-operative deaths, 17 occurred during the operative procedure. Had we not attempted operation these patients would surely have died but would have

been considered nonoperative deaths. However, we have had a number of similar cases who appeared as hopeless operative risks but did survive major operative procedure to go on to recovery. It is this group of patients that has made worth while the undertaking of surgery in the bad risk cases. We have had 25 other patients who died without surgery having been performed. Most of these were admitted in a moribund state and died within a few minutes to a few hours after admission.

The following case report illustrates the type of bad risk patient in whom the final result was successful:

Case 1.—A soldier wounded 0300, July 28, was admitted to the hospital at 0500, same date. He had a penetrating wound of the left chest due to a bomb fragment. He was in profound shock, dyspnea was marked, and pain was very severe. There was external bleeding from the wound, and physical examination suggested the presence of a left hemothorax. Roentgenologic examination disclosed the presence of fluid in the left chest and also a bomb fragment in the abdominal cavity.

One thousand cubic centimeters of whole blood was given. The blood pressure failed to rise above systolic 64, diastolic 40. Because the patient showed evidence of continued bleeding he was prepared for immediate operation. Under intratracheal positive pressure anesthesia of nitrous oxide, oxygen and ether, open thoracotomy was performed. The chest cavity was found to contain omentum and transverse colon, the latter almost completely transected and fecal contents free in the pleural space. A severely lacerated spleen, bleeding actively, was also present in the chest cavity. The left lower lobe of the lung was found to be lacerated.

The operative procedure consisted of suture of the laceration in the lung, splenectomy, and repair of the multiple lacerations in the diaphragm. Closed system catheter drainage was provided. The abdominal cavity was then explored through a midline incision and all blood was aspirated from the peritoneal cavity. The severed ends of the transverse colon were brought out through a stab wound as a colostomy. The abdomen was closed without drainage.

The patient was given 1,000 cc. of whole blood during the operation during which his general condition remained unchanged. Postoperative therapy included an additional 1,500 cc. of whole blood and continuous intranasal oxygen. Wangenstein drainage was instituted and continued for three days. He was given 40,000 units of penicillin every four hours and sulfadiazine to maintain a blood level of between 8 and 12 mg. per 100 cc. A total of 25 Gm. of sulfadiazine and 840,000 units of penicillin were given.

The patient had a mild postoperative course. The highest temperature postoperatively was 100.6° F., pulse 130. Drainage from the catheter in the pleural space was considerable. The catheter was removed on the third day. Hematuria was present for the first few days but cleared. On the seventh day 800 cc. of straw-colored fluid was aspirated from the left pleural cavity. The patient's progress had been very satisfactory, and he was evacuated to a rear hospital on the ninth postoperative day.*

Chart I shows that the time factor between injury and operation has a definite bearing on the mortality rate. The mortality rate for patients operated on within six hours was 30 per cent. This dropped in the subsequent six-hour periods to reach 10 per cent at the 24- to 30-hour period. This can be explained by the fact that the most desperate cases, those in shock resulting

* All abdominal cases are held in this hospital for a minimum of ten days. This particular patient was transferred to another nearby Evacuation Hospital on the ninth postoperative day because the military situation necessitated moving this hospital.

from active hemorrhage, were operated upon in the first six-hour period. The mortality rates after the 30-hour period may be misleading since they are based on a very small number of cases operated upon during that period.

We do not advise delay in operation for these cases. We do believe, however, that sufficient time be taken to prepare patients more adequately for operation. Those patients who begin to respond to the shock therapy are

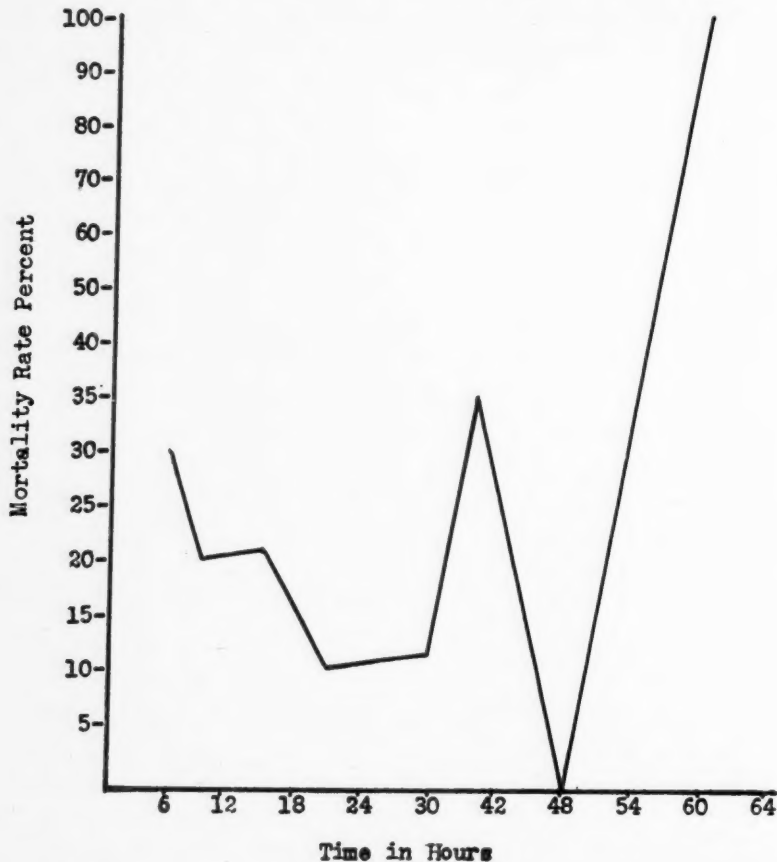


CHART I
OPERATIVE MORTALITY RATE IN RELATION TO TIME-LAG FOLLOWING INJURY

probably better risks if given a few additional hours to improve and stabilize their general condition. Early in the campaign we were enthusiastic regarding early surgery in these cases. This enthusiasm has diminished with experience. It is our impression that the use of chemotherapy has made possible the good results in some of these late cases.

There is a large percentage of patients with intra-abdominal injuries who, in addition, have other major injuries. We have had 81 cases with combined chest and abdominal injuries, ten cases with combined head and abdominal injuries, and seven cases with abdominal injuries combined with traumatic

amputations of an extremity. Patients with compound fractures of one or more of the long bones as associated injuries are not infrequent. Each patient with multiple major injuries presents a separate problem in surgical management. The separate injuries may each require a major operative procedure. Because of the condition of the patient it may be necessary to perform these operations successively or on different days. Multiple major operations performed at the same time by several surgical teams may throw the patient into irreversible shock. The following patient demonstrates the type of battle casualty upon whom multiple operations had to be performed successively and on different days:

Case 2.—A soldier wounded 2300 hours, September 29, was admitted 0800, September 30. Patient had sustained multiple severe wounds of head, chest, abdomen, left arm and left foot due to shell fragments. He was unconscious on admission. His blood pressure was elevated, being systolic 150, diastolic 80. There was questionable viability of the left foot. The patient was treated with blood, plasma, glucose and saline solution and sedatives. His response was slow and operative procedure had to be delayed until October 1, 36 hours after injury. On this date, under endotracheal anesthesia of nitrous oxide, oxygen and ether, débridement of the chest wound and open thoracotomy were performed. Two hundred cubic centimeters of blood was aspirated from the pleural space and a long laceration of the diaphragm was sutured. Tight closure of the chest was accomplished. Exploratory celiotomy disclosed no intra-abdominal injury. The foreign body was not recovered. Penicillin and sulfanilamide powder was applied to the various wounds and further surgery postponed.

The patient had a moderate postoperative reaction, pulse 110 to 140, blood pressure rose from 88/50 to 124/60. He was given several transfusions of blood and plasma. He continued to be drowsy but could be aroused. He was incoherent.

On October 2, under local anesthesia, a large lacerated wound of the scalp was excised and a fracture of the outer table of the skull was exposed. Closure of the scalp wound was accomplished. The patient was conscious but disoriented during operation. On October 3 the patient was clearer mentally. The wound of the left arm was exposed and 40,000 units of penicillin and sulfanilamide powder instilled into the wound. The traction splint was maintained. On October 4 the patient was conscious and rational. The slight facial weakness noted originally persisted. His fundi showed bilateral blurring of the disks. The spinal fluid was under normal pressure.

On October 8, because of circulatory failure in the left foot resulting from the original trauma, a guillotine amputation of the lower third of the left leg was performed under pentothal anesthesia. The patient's general condition improved considerably. His sensorium was clear. His temperature was normal and his pulse varied between 80 and 120. On October 13 a plaster encasement was applied to the left arm to control the fracture of the humerus, and the patient was prepared for evacuation to a Rear Hospital.

We have found that a certain small group of cases could be treated without abdominal exploration. This includes patients with retroperitoneal hemorrhage in whom the active bleeding has stopped and who have recovered from the shock state. A few cases with perforating wounds high in the right upper quadrant of the abdomen, even with a foreign body present in the liver, also responded well to nonoperative treatment. Patients with generalized blast injury should also have expectant treatment as a general rule. All these patients should, of course, have adequate débridement and drainage of their

wounds. However, in cases of questionable intra-abdominal injury, exploratory celiotomy should be carried out. We have performed 19 exploratory celiotomies in which no intra-abdominal injury was present. There were no deaths.

Inhalation anesthesia by nitrous oxide, oxygen, and ether in a closed system, preferably with intratracheal intubation, has been our anesthetic of choice. This form of anesthesia is imperative in combined thoraco-abdominal injuries since it allows for positive pressure. Open-drop ether has its particular use in patients in severe shock from internal hemorrhage. Spinal anesthesia has no place in abdominal surgery of battle casualties. Pentothal is not a satisfactory anesthetic in this type of case and should not be used. Regional anesthesia by using intercostal nerve block was used in three cases where a general anesthetic would have been too great a burden for the patient. It is unnecessary to infiltrate novocaine in the abdominal wall with intercostal nerve block. These were cases of severe shock associated with hemorrhage. Local infiltration and regional block are valuable in patients with additional extensive face or blast injury which precludes the use of any inhalant anesthetic. The following patient demonstrates the extensive surgical procedures which were carried out under regional anesthesia:

Case 3.—A Belgian female, age 30, wounded by artillery shell fragment, 1200 hours, November 15, was admitted to this hospital 1500 hours, November 15. The patient was in profound shock. Examination revealed a penetrating wound of the right upper quadrant of the abdomen and a laceration of the right forehead. The blood pressure was 90/60, and pulse 140. There was generalized abdominal tenderness and rigidity, but these were more marked in the right upper quadrant. The urine was grossly bloody. She was given blood and plasma preoperatively without any marked response. A diagnosis of continuing intra-abdominal bleeding was made, and operation was performed. Under bilateral block of the seventh to eleventh intercostal nerves with 60 cc. of 1 per cent procaine hydrochloride supplemented with 0.37 Gm. of sodium pentothal intravenously, exploratory celiotomy was carried out. The patient was found to have a severed cystic artery, perforating wounds of the gallbladder, kidney and liver. The cystic artery was ligated, the gallbladder was removed, the liver wound was packed and the kidney wound was sutured. She was given 1,500 cc. of whole blood and 1,500 cc. of Alsever's solution during the operation. The postoperative course was stormy for the first seven days, after which her improvement was rapid, and she was evacuated on the 12th postoperative day in good condition.

In combined chest and abdominal injuries we have found it preferable to do the chest surgery before the abdominal surgery is performed. It is important to stabilize the respiratory exchange, reduce the shock, and give the patient maximum help to withstand the additional hazard of the anesthetic.

The common intrathoracic procedures were aspiration of an hemothorax, removal of a foreign body or imbedded rib fragments from the lung, and suture of a lacerated diaphragm. In large penetrating thoraco-abdominal wounds, the transthoracic approach to the diaphragm has been most useful, and suture of the diaphragm is relatively easy. Splenectomy and suture of

the stomach through the thoracic approach can be readily performed. Even suture of the small intestine becomes feasible if the opening in the diaphragm is enlarged sufficiently.

For surgical exploration of the abdominal cavity adequate exposure is essential to visualize all parts. This may involve the use of long abdominal incisions, but these generally heal well. The proper location of the incision over that part of the abdomen most involved will facilitate the intra-abdominal operative procedure and shorten the operative time. Paramedian incisions with separation of either of the recti muscles were used most frequently. Exposure through subcostal incisions proved very useful especially in cases with injuries to the stomach, liver and spleen, and the hepatic and splenic flexures of the colon. Anticipation of the necessity for colostomy may alter the site of the incision.

It is important to make a systematic examination of the abdominal contents. Injuries were frequently multiple and were often far removed from one another. The entire small intestine should be examined serially before individual perforations are sutured. Even when perforations are multiple in adjacent areas suture of the separate perforations is preferable to resection. There is no need for excision of the mucosa. We have sutured as many as 16 individual perforations in one short segment of the small bowel. One must be especially careful not to overlook perforations. Autopsies disclosed that in six cases single perforations had been overlooked at the original operation. There were four such cases involving the small bowel, one the stomach and one the cecum. Resection of a portion of the small intestine is indicated when the mesentery is detached over a length greater than two inches. End-to-end anastomosis is the procedure of choice because of its simplicity and time-saving value. Enterostomy of the small intestine should not be done.

Small wounds of the cecum and the ascending colon may be sutured and a large Pezzar catheter placed in the cecum as a safety valve. In wounds of the transverse colon, descending colon and sigmoid we have used the Mikulicz or loop-type of colostomy. It has been pointed out by the surgeons who do the secondary closure that the loop-type is preferable. The involved loop with the colostomy opening should be brought out through a separate incision rather than through the original operative incision. This separate incision is most important since it obviates severe infection and wound disruption which frequently occur when the damaged bowel segment is brought out through the original operative incision. The exteriorized loop must be free of tension.

Thirty-four patients had rectal perforations and, of these, six were intraperitoneal and 28 extraperitoneal. Intraperitoneal perforations should be sutured and an inguinal sigmoidostomy performed to divert the fecal stream. In extraperitoneal rectal wounds adequate drainage is most important and this may necessitate removal of the coccyx. Drainage through the gluteal muscles should be avoided when possible. In all rectal wounds, whether

intraperitoneal or extraperitoneal, a proximal colostomy should be performed to prevent further soiling and to allow for healing of the injured part.

We are impressed with the large number of patients who had hemoperitoneum with large quantities of both clotted and unclotted blood. In a great percentage of the cases the source of the hemorrhage was found to be the spleen. We had 26 cases of severe laceration of the spleen. In extensive lacerations or severe bleeding from this organ splenectomy is indicated. There were a few cases with very superficial lacerations which did not require suture. There were no cases of secondary hemorrhage. Most of these cases had associated major injuries and splenectomy would have increased the hazard of operation. In some patients splenectomy was performed to allow more adequate exposure for suture of a lacerated diaphragm.

Transfusion with whole blood and plasma during the operative procedure is especially important even though large quantities may have been used in the preoperative management. We have noted that there were no transfusion reactions while patients were under general anesthesia. This observation is worthy of further investigation.

Liver wounds are best managed by packing, or by use of a free muscle graft. Recently cellulose-acetate gauze (absorbable) has been made available to Army units for hemostasis in liver and kidney wounds. To date we have had no experience with the use of this material. Drainage should always be established below the level of the diaphragm. The diaphragm should be closed securely in right thoraco-abdominal injuries associated with liver wounds. Interrupted fine silk sutures are used to close each leaf of the diaphragm. In most of these cases the foreign body was in the substance of the liver and was not removed. Unless the diaphragm is closed and adequate drainage instituted a biliary-pleural fistula, liver abscess, or sub-diaphragmatic abscess may result.

All abdominal incisions should be closed carefully in layers and reinforced with silk or wire retention sutures down to the peritoneum. These sutures should be evenly spaced and in sufficient number. They should be tied very loosely to prevent necrosis of the intervening tissue. Drainage of the peritoneal cavity is not necessary except in wounds of the liver. These drains are left in for ten days.

There were no special problems in the postoperative period of our patients. Intestinal obstruction in the early postoperative period, even after extensive surgical procedures, was rare. The routine use of intravenous fluids, at least 3,000 cc. daily, maintained hydration. Wangenstein drainage was used routinely on all postoperative abdominal cases, and was most important in preventing postoperative distention. The Miller-Abbott tube was found useful in several patients, and the usual difficulty in its passage was minimized by the use of mercury in the bulb. The use of prostigmine prophylactically in the immediate postoperative period showed good results in several cases.

Our postoperative routine included the intramuscular injection of 20,000 units of penicillin every four hours for at least 18 doses. The value of

penicillin in preventing postoperative pulmonary complications can readily be shown by the small number of such complications in this large series. We had an incidence of 1.6 per cent. Postoperative wound infection was rare, and this is attributed to the use of penicillin and the sulfa drugs. Our postoperative routine also included the use of vitamins. These were given orally when possible or intravenously when necessary. The routine dose was 1,000 mg. of ascorbic acid and 20 mg. of thiamine hydrochloride daily. Adequate blood protein levels were maintained by the liberal use of plasma and whole blood was used to increase the red cell count and hemoglobin levels.

SUMMARY

1. A series of 341 patients with abdominal war wounds is presented. This includes 81 patients with combined thoraco-abdominal wounds. Surgery was performed on 312 patients. Many of these patients had additional major injuries. The operative mortality was 20.2 per cent. Eight per cent of the patients died without surgery having been performed.
2. The methods used in making the diagnosis of intra-abdominal injury including the importance of proctoscopic and sigmoidoscopic examinations are discussed.
3. The importance of adequate preoperative treatment as a determining factor in the final result is stressed.
4. The decrease in mortality rate on patients operated upon six to 30 hours after injury is explained in part by the fact that the worst cases are operated upon during the first six-hour period. Delayed operation is not advocated but rather the effort to prepare the patient adequately for operation is stressed.
5. The importance of early surgery in patients with evisceration of abdominal organs is noted. These patients do not respond to the usual forms of shock therapy until surgical replacement of the evisceration is accomplished.
6. Certain surgical procedures that we have employed in the operative management of the various types of injuries encountered are presented.
7. The importance of adequate and well-placed incisions, of systematic and thorough abdominal exploration, and careful abdominal closure is discussed.
8. The necessity for careful closure of the diaphragm and institution of subdiaphragmatic drainage in right-sided thoraco-abdominal wounds is emphasized.
9. The value of intensive postoperative treatment, including the use of penicillin and the sulfa drugs, is shown by the low incidence of postoperative complications.
10. Case histories of selected cases are presented in detail.

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CHEMOTHERAPY IN TRAUMATIC SURGERY OF THE ABDOMEN

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THE TRUE EFFICACY of the sulfonamides and penicillin in the treatment and prevention of intraperitoneal infection is yet to be determined. It is our impression that they have been highly effective, but without a comparable control group it cannot be definitely established. This report is concerned with chemotherapy as applied to war injuries with peritoneal penetration. During the past year of the Italian campaign we have had 243 such cases. The sulfonamides were used for approximately the first half of the year. For the latter half penicillin became available and has been used on a slightly greater number of cases. This group includes only those cases having proven peritoneal penetration, and those with subparietal injuries with perforation of the intestine, which received chemotherapy.

Sulfonamides: In 112 cases the sulfonamides were used exclusively. In 69 of these cases sulfonamide was applied intraperitoneally in amounts varying from 6 to 12 Gm. of sulfonamide powder at the time of operation, in addition to subsequent intravenous and oral administration. All cases routinely received 5 Gm. of sodium sulfadiazine intravenously each 24 hours for the first three or four postoperative days. As soon as oral administration was tolerated, sulfadiazine was given in doses of 1 Gm. four times daily. Its use was maintained until the patient became afebrile or from clinical indications free of danger of peritoneal infection. Rarely was it given for a period longer than seven to ten days altogether. In 60 additional cases sulfanilamide powder was applied intraperitoneally, but was followed by postoperative penicillin therapy. The sulfonamides with few exceptions were well tolerated and in no case was there a serious reaction.

Penicillin: In 129 cases penicillin has been used. In 60 of these sulfanilamide powder was applied locally and followed by penicillin intramuscularly; in 13 cases penicillin was used locally and followed by its intramuscular administration; and in 58 cases penicillin intramuscularly only was used. The intraperitoneal dosage of the drug was 50,000 units. The intramuscular dosage was 25,000 units every three hours. Its use was kept up for a period of a week or ten days, or until the danger from peritoneal infection, as determined from clinical progress, had passed.

Although 243 cases had peritoneal penetration by missiles which undoubtedly carried in foreign material and some bacteria, and might well have had peritonitis develop from that source, only in the group with intestinal perforations did it actually occur. Hence, the cases appear in Table I so designated. The total number of deaths for the two groups is also shown. There were four deaths in the group of 86 cases without intestinal perforations and 37 deaths in the group of 157 cases with intestinal perforations.

INTRA-ABDOMINAL CHEMOTHERAPY

Such a marked difference in the mortality is due chiefly to the fact that the latter group represents the more severely wounded, since peritoneal infection was the principal cause of death in only 12 cases. Of those 12 cases five were such that little or no benefit could be expected from chemotherapy. In the last column is shown the seven deaths from peritonitis which were thought possibly amenable to chemotherapy.

TABLE I
TYPES OF CASES AND RESULTS OBTAINED FROM CHEMOTHERAPY

Drug	Route of Administration	No. of Cases	Deaths	Cases with Hollow Visceral Perforation	Deaths	Deaths from Peritonitis	"Preventable" Deaths from Peritonitis
Sultonamides	Local, intravenous and oral	69	14	58	13	4	2
Sulfonamides	Intravenous and oral	43	2	16	2	2	1
Sulfanilamide	Local and intramuscular	60	9	52	9	3	1
Penicillin							
Penicillin	Local and intramuscular	13	5	9	5	2	2
Penicillin	Intramuscular	58	11	22	8	1	1
Total		243	41 (16%)	157	37 (23%)	12	7

COMMENT: Although perhaps too small a group to justify conclusions, it is our impression that the local use of either drug affords no additional protection against peritoneal infection. Our experience fails to indicate any particular advantage of one drug over the other or that their combination as employed has proven more efficacious than either alone. Indeed, it is impossible to know just to what degree either drug is effective, if at all. Of the 157 cases with hollow visceral perforation, 148 of which were of the small intestine and colon, there were only seven deaths attributed to "preventable" peritonitis—a much smaller number than would be expected without chemotherapy. That figure is even more striking when the frequency of extensive peritoneal soiling and prolonged time-intervals between wounding and operation are considered.

In addition to the infrequency of deaths from peritonitis there has been no instance of a diffuse suppurative process. We have yet to see an abdomen distended with a large quantity of free pus, as was so often found at autopsy following intestinal perforations and operations before the advent of effective chemotherapeutic agents. The peritonitis observed has been chiefly of the fibrinous plastic type, producing numerous points of mechanical obstruction and ileus. Whenever purulent exudate has been observed it has been localized. Without exception those deaths attributed to peritonitis have occurred in the most severely wounded cases, which barely escaped death from shock and only then following the use of large quantities of plasma and whole blood. At autopsy in such cases, it is difficult to ascertain whether the severe and prolonged shock, the peritonitis or the usual bronchopneumonia in the lower lobes is chiefly responsible for the fatality. We believe that it is the com-

TABLE II
ANALYSIS OF DEATHS FROM PERITONITIS

Case No.	Diagnosis	Time Involved (Injury to Operation)	Operative Findings	Operative Procedure	Chemotherapy	Course and Autopsy Findings
1—Italian Civilian	Gunshot wound, perforating abdomen	3-4 days	Diffuse purulent peritonitis. Nine ileal perforations	Suture of perforations	Sulfonamides, locally and intravenously	Died 48 hours postoperatively
2—German P.O.W.	Shell fragment wound penetrating abdomen	3 days	Diffuse purulent peritonitis. Two ileal and one cecal perforations	Suture of perforations	Sulfonamides, locally and intravenously	Died 48 hours postoperatively
3—American Soldier	Shell fragment wound penetrating abdomen	17 hours	Multiple perforations in ileum, ascending colon and sigmoid	Two ileal resections and anastomoses; exteriorization of terminal ileum and right colon	Sulfonamides, locally and intravenously	Died 9 days postoperatively. Fibrinous peritonitis
4—American Soldier	Shell fragment wound perforating abdomen	3 hours	Transsections of ileum and transverse colon	End-to-end ileal anastomosis; ends of transverse colon exteriorized	Sulfadiazine, intravenously	Died 9 days postoperatively. Fibrinous peritonitis
5—German P.O.W.	Shell fragment wound perforating rectum	2-3 days	Diffuse purulent peritonitis; jejunal, rectal and bladder perforations	Suture of jejunal perforation, sigmoidostomy. Cystostomy	Sulfadiazine, intravenously	Died 24 hours postoperatively
6—German P.O.W.	Gunshot wound perforating bladder	22 hours	Laceration of bladder	Suture of laceration. Cystostomy	Sulfanilamide, locally. Penicillin, intramuscularly	Died 3 days postoperatively. Localized suppurative peritonitis from overlooked jejunal perforation
7—Italian Civilian	Shell fragment wound penetrating abdomen	24 hours	Early diffuse peritonitis, perforations in ileum, ascending and transverse colon	Suture of ileal and ascending colon perforations. Transverse colon exteriorized	Sulfanilamide, locally. Penicillin, intramuscularly	Died 5 days postoperatively. Diffuse fibrinopurulent peritonitis
8—American Soldier	Shell fragment wound perforating abdomen	2 hours	Transsections of ileum and splenic flexure of colon. Lacerations of spleen and left kidney, slight	Ileal anastomosis. Colon ends exteriorized	Penicillin, intramuscularly locally and intramuscularly	Died 8 days postoperatively. Localized suppurative peritonitis; bronchopneumonia
9—Italian Civilian	Bomb fragment wounds penetrating left chest and abdomen	9 hours	Early diffuse peritonitis; six jejunal and two descending colon perforations	Suture of jejunal perforations. Descending colon exteriorized	Penicillin, locally and intramuscularly	Died 7 days postoperatively. Localized suppurative peritonitis; bronchopneumonia
10—American Soldier	Shell fragment wound penetrating buttocks and abdomen	4 hours	Early diffuse peritonitis. Multiple jejunal and intraperitoneal rectal perforations	Jejunal resection and anastomosis; suture of rectal perforation and proximal sigmoidostomy	Penicillin, intramuscularly	Died 10 days postoperatively. Fibrinopurulent peritonitis
11—American Soldier	Shell fragment wound perforating spine and abdomen	3 hours	Transsections of jejunum and splenic flexure of colon	Jejunal resection and anastomosis; ends of colon exteriorized	Sulfanilamide, locally and intramuscularly	Died 6 days postoperatively. Fibrinous peritonitis
12—Italian Partisan	Shell fragment wound penetrating abdomen	10 hours	Transsection of splenic flexure of colon. 3 perforations in stomach, laceration of spleen, slight. Lacerations of pancreas and left kidney	Ends of colon exteriorized; perforations of stomach sutured. Nephrectomy	Sulfanilamide, locally. Penicillin intramuscularly	Died 3 days postoperatively. Fibrinopurulent peritonitis. Bronchopneumonia

mination of those conditions which prove fatal and without the other two, recovery would frequently take place from the peritonitis alone. Certainly, without the peritonitis recovery would undoubtedly occur from shock and the pulmonary disturbance in many instances.

As indicated in Table I, there were 86 cases with peritoneal penetration, but without gastro-intestinal perforations. In no case of this group was there significant peritoneal infection.

The combined use of penicillin and the sulfonamides other than the more local application of the latter appears to have certain theoretic advantages. Recently, in a single case such was the treatment and with, thus far, a favorable outcome.

Case Report.—American soldier. Admitted October 16, 1944. Shell fragment wound, penetrating left lumbar region and abdomen two hours prior to admission. General condition fair. Abdomen rigid. *Operative Findings:* A large amount of blood and intestinal contents in the peritoneal cavity. Descending colon three-fourths severed. Jejunum severed in two places near ligament of Trietz and two smaller lacerations more distally. *Procedure:* Resection of three feet of jejunum with an end-to-end anastomosis. Suture of the two other jejunal lacerations. Exteriorization of injured segment of the descending colon. Through-and-through wire suture closure of abdominal incision. *Chemotherapy:* Sulfonamides administered locally, intravenously and orally; penicillin intramuscularly. *Course:* Since third postoperative day intestinal function has been satisfactory. Recovery uneventful except for operative wound infection.

As shown in Table II, Cases 1, 2 and 5 were found to have far advanced generalized suppurative peritonitis at the time of operation and could not reasonably be charged against the efficacy of chemotherapy. Case 6, with an overlooked perforation, and Case 12, with such extensive injuries and profound shock as to survive for only 72 hours, should properly be similarly considered. The seven remaining cases represent the deaths from peritonitis which were considered preventable. Four of the seven cases received penicillin and three sulfonamide therapy.

• CONCLUSIONS

- (1) The sulfonamides and penicillin appear to be about equally effective in the treatment and prevention of peritonitis.
- (2) The local use of either drug does not appear to offer additional protection against peritonitis.
- (3) Their combined use would seem to warrant further trial.

LUNG ABSCESS COMPLICATING PENETRATING WOUNDS OF THE CHEST

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FROM THE GENERAL SURGICAL SECTION OF A NUMBERED GENERAL HOSPITAL, COLONEL JOHN G. KNAUER, M.C.,
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LUNG ABSCESS following penetrating wounds of the chest have been uncommon in World War II. A British chest team¹ reviewed 291 cases of penetrating wounds of the chest incurred during the African Campaign and reported three cases of lung abscess following penetration of the chest, an incidence of about 1 per cent. Holman² reported 36 penetrating gunshot wounds of the chest from the Pacific Combat Area and did not mention the occurrence of lung abscess. The authors have treated 122 patients with penetrating wounds of the chest in a General Hospital operating in the Italian Theater. Among these cases were two patients that developed lung abscess, an incidence of 1.6 per cent. One developed rapidly about a large foreign body and the other was a complication of prolonged intrathoracic sepsis.

It is not clearly understood why pulmonary abscesses develop about some retained foreign bodies and not about others. It has been suggested that pieces of clothing driven into the lung by large foreign bodies may carry the infecting organisms. Skin and other extraneous foreign materials have also been blamed. It may be noted that the organisms found in the pus in Case 1 are not those usually associated with clothing and skin, but more frequently respiratory flora. The authors have removed several intrapulmonary metallic foreign bodies, along with pieces of uniform, and in these cases there was no evidence of pulmonary suppuration at the time of operation or during the convalescent period. It is probable that the heat of shell fragments is sufficient to sterilize most pathogenic organisms.

A circumscribed area of density of varying degree has been noted roentgenologically about retained metallic foreign bodies in the lung in numerous cases. Whether this is an area of pneumonitis representing infection or density caused by infiltration of blood is not clear, because practically all of these changes disappear within 10-14 days following their appearance. An elevation of temperature may or may not occur during this time.

CASE REPORTS

Case 1.—This 26-year-old male was wounded in action by an enemy shell fragment on January 31, 1944. The fragment entered the right upper arm near the posterior axillary fold and traversed the right chest wall, entering the right upper lung field. Treatment in the field consisted of 4 Gm. of sulfadiazine orally, two units of

LUNG ABSCESS

plasma (500 cc.), and a sterile dressing and sulfanilamide crystals applied to the wound. Due to the difficult line of evacuation during this particular military operation the patient was not received at this hospital until February 3, 1944, approximately 72 hours after sustaining the wound. On admission, his temperature was 102° F., pulse 122, respirations 28. He was moderately dyspneic and cyanotic, and he complained of severe pain in the right side of the chest. Hemoptysis was minimal, and a slight shift of the heart to the left was noted. The right chest was dull to percussion throughout and the breath sounds were diminished at the apex and obscured below this area. Roentgenograms



FIG. 1



FIG. 2

FIG. 1.—Extent of the abscess in Case 1 on the day of operation is shown. This was 12 days after the wound was sustained.

FIG. 2.—Lateral view in Case 1 showing the posterior position of the abscess.

showed a uniform density clouding over the entire right lung field, and a large metallic foreign body, measuring 1.5 x 3 cm., lying in the posterior part of the right chest at the level of the eighth rib, 6 cm. to the right of the spine. Treatment on admission consisted of continuous oxygen by nasal catheter and 1,000 cc. of whole blood along with sulfadiazine, 1 Gm. every four hours orally (at this time penicillin was not available for general use). Only 6 cc. of blood was obtained on thoracentesis, although the attempt to evacuate blood from the chest was made through four different interspaces. Culture of this blood proved to be sterile. Repeated roentgenograms were taken and, on February 7, seven days after injury, there was definite evidence of a lung abscess around the foreign body. Another transfusion of 1,000 cc. of whole blood was given on February 8. Further roentgenologic study revealed rapid progress in the growth of the cavity and on February 12 it measured 10 cm. in diameter. The temperature had been "spiking" daily to 103° F.

Operation.—February 12, 1944: Under endotracheal, nitrous oxide-oxygen-ether anesthesia, a curved incision was made posteriorly from the level of the fourth rib, laterally to the ninth rib in the axillary line. The seventh and eighth ribs were denuded of muscle and periosteum for a distance of about three inches, and the intercostal bundles in this region were excised. Examination showed that the parietal and visceral pleura were adherent, and aspiration revealed that the abscess was directly below the exposed area. Sections of both ribs were then removed and the entire roof of the abscess cavity was excised, revealing a fetid cavity containing 450 cc. of pus. The shell fragment was found free within the cavity and removed. Several small, incomplete loculations were broken down and the cavity completely emptied. It was carefully packed with strips of

tight mesh dry sheeting to include all recesses. The upper and lower poles of the wound were lightly approximated with chromic catgut.

Smears of the pus showed predominant *Spirochaetes* and fusiform bacilli, and culture revealed gram-positive spore-forming bacilli and diphtheroids predominating.

Starting on the seventh postoperative day, the packing was loosened and two to three inches removed every other day. The postoperative course was entirely satisfactory until March 3, 1944, when the patient began to have a higher elevation in temperature and complained of pain in the left thigh. On March 6, 1944, the left leg and thigh were markedly swollen and hot. The calf and anterior thigh were tender to moderate pressure. The diagnosis of acute femoral thrombophlebitis was made. Under pentothal sodium anesthesia, on the same day, the left femoral vein was exposed and found to be filled with soft, but adherent clot. The vein was divided high and doubly ligated with silk, above and below the division. There was a dramatic and almost immediate relief of pain and a rapid disappearance of swelling within one week following the vein ligation. Culture of the blood clot revealed no growth.

On March 15, 1944, penicillin was available and was given in doses of 25,000 units intramuscularly every three hours. This was discontinued on March 28, 1944, after the patient's temperature had been normal for three days. During this period of time a careful check of the hematocrit, hemoglobin, and plasma proteins was made, employing the Van Slyke copper sulfate method. Any deviation from the normal was corrected with whole blood transfusions. During his stay in this hospital the patient received a total of 4,500 cc. of whole blood.

Postoperative roentgenograms were taken at intervals, and, on May 9, 1944, the abscess cavity was no longer visualized. The patient was evacuated to the Zone of Interior on May 21, 1944, and at that time the chest was completely healed and there was no evidence of suppuration.

Case 2.—A 25-year-old male was wounded in action by enemy shell fragments on February 20, 1944. He sustained a large penetrating and avulsing wound of the right lower, lateral chest wall, with laceration of the lower lobe of the right lung, diaphragm and liver. He was operated upon within 12 hours at a Forward Hospital, where a partial lobectomy of the right lower lobe was done. The shell fragments were removed and the diaphragm repaired. The liver was packed and drained through a subcostal stab wound. He developed an empyema, which was drained through the original wound.

He was admitted to this hospital, March 7, 1944, in poor condition. His temperature was 102.8° F., pulse 128, respirations 30. There was a huge, open suppurating wound of the right lower chest wall, measuring 20 x 9 cm. Roentgenograms revealed a total clouding of the right lung field. Thoracentesis was done, and a thin, nonfetid purulent exudate was obtained. Oral sulfadiazine and blood transfusion therapy was started on admission. On March 9, 1944, a closed intercostal thoracotomy was done, with water-tight drainage. A large amount of pus was evacuated and culture showed a predominant growth of *Staphylococcus aureus*. In spite of this apparently adequate drainage the patient continued to run a febrile course and subsequent roentgenologic studies showed the presence of a large lung abscess in the right midlung field. Penicillin therapy was started on March 16, 1944, and 25,000 units were given every three hours intramuscularly, along with necessary blood transfusions. The patient showed a marked tendency toward anemia, and the hematocrit, hemoglobin and plasma proteins, employing the Van Slyke copper sulfate method, were frequently much below normal. On March 22, 1944, the patient was operated upon, employing essentially the same technic as in Case 1. Culture from the pus in this abscess showed predominant *non-hemolytic Streptococci* and diphtheroids.

The healing of the abscess in this patient was exceptionally rapid, and roentgenograms demonstrated complete obliteration of the cavity on April 24, 1944. The large chest wall wound was healing well by granulation and the operative wound over the

abscess was almost completely healed when the patient was transferred to a Canadian General Hospital on May 18, 1944.

COMMENTS: The one-stage operation for drainage of lung abscess was favored in these patients because it was possible to make accurate roentgenologic localization of the abscesses, showing their proximity to the periphery. The fact that they were large solitary lesions also favored the one-stage procedure. The essential feature in the technic of the operation is not simple drainage, but complete unroofing of the abscess. This allows for more com-

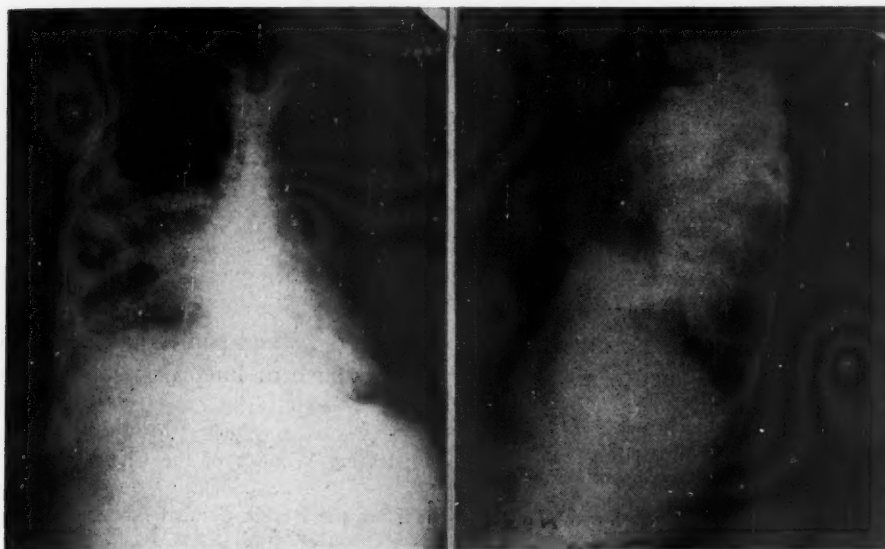


FIG. 3

FIG. 4

FIG. 3.—Postero-anterior view of the chest in Case 2 showing the huge abscess cavity.

FIG. 4.—Lateral view in Case 2 outlining the posterior position of the abscess.

plete emptying of the cavity and, subsequently, a more rapid reëxpansion of the lung and obliteration of the pyogenic membrane. Dry, tight-mesh packing, placed into the cavity to include its entire surface, is favored over vaselined gauze. Vaseline produces unwanted maceration, and there is always the fear of aspiration of some of the vaseline through a small bronchial fistula, with the possibility of lipoid pneumonia complicating the picture.

The completeness with which these cases healed may be attributed to adequate drainage plus the use of penicillin and blood transfusions. It is believed by the authors that, although drainage in this type of lung abscess is without question the most important step, penicillin and the intelligent use of whole blood contribute greatly to the recovery of these patients. It seems logical that whole blood presents the best means available for replacing body elements lost by suppuration.

Neuhof and Hurwitt³ speak of the problem of wound closure following the drainage of lung abscess and mention the persistence of anaerobic infection in the wounds as the reason for the difficulty in achieving early and

complete healing. The use of whole blood transfusions combined with penicillin therapy has been shown to be of great value in controlling infections in war wounds of all types. It is logical that the application of these principles to the treatment of lung abscess may be a very valuable adjunct to surgical drainage. It must be stressed that 500 cc. of blood does not always constitute an adequate transfusion, but that transfusions of 1,000 cc. of whole blood are more likely to give the desired result.

In Case 2 frequent checking of the hematocrit, hemoglobin and plasma proteins, by Van Slyke's copper sulfate method, revealed a marked tendency toward anemia, and a slight decrease in the plasma protein level so frequently seen in patients with chronic suppurating lesions. A total of 9,500 cc. of whole blood was administered to the patient in order to maintain a relatively normal blood picture.

SUMMARY

(1) The occurrence of lung abscess following penetrating wounds of the chest has been uncommon in our experience.

(2) Two cases of lung abscess following penetrating wounds of the chest are presented and discussed.

(3) The usefulness of whole blood transfusions and penicillin is stressed as a valuable adjunct to adequate surgical drainage of lung abscesses.

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THE OPERATIVE TREATMENT OF DECUBITUS ULCER

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DECUBITUS ULCER is an unfortunate, sometimes unavoidable complication of this war. Let there be but a short period, perhaps only a few hours, in the chain of evacuation of one of these battle casualties, during which time the patient is allowed to lie on his back or side without frequent turning and change of linen, and the sacral or trochanteric ulcer is already present.¹ Needless to say, vigorous steps to eliminate this complication in paraplegic casualties have already been taken.

Paraplegic casualties in many ways are a challenging problem in the General Hospital in the United States. In order to prepare them for the ambitious program of rehabilitation designated for them by the Medical Department, sepsis must be controlled, especially ascending urinary infection, malnutrition must be corrected by restoring positive nitrogen balance, decubitus ulcers must be healed, and an attempt must be made to secure an automatic bladder if possible.

Confronted with such a problem, the old approach to the treatment of decubitus ulcer is entirely inadequate. No matter what local medicaments are used, it still requires six to 12 months for the complete epithelization of a large sacral ulcer. Moreover, the end-result leaves much to be desired since a thin unstable epithelium overlies the bony structure of the sacrum and coccyx with but a thin layer of fibrous tissue intervening. If the patient is destined to remain a paraplegic, this epithelium is readily subject to the vicissitudes of unavoidable abuses, especially if the area remains anesthetic, as a result of which it may ulcerate repeatedly. If the patient recovers, the result may be still more unsatisfactory.

Cautiously at first, but with increasing vigor, the Medical Department attacked the problem. About a year ago, the military surgeons began to cover cleanly granulating ulcers with free grafts. A few used pinch grafts, others employed Thiersch grafts. Some of the results were gratifying, the ulcers being completely epithelized in a relatively short period. In retrospect, there is little to be said for the use of pinch grafts. The ulcer may be completely epithelized somewhat sooner, but it still requires months to secure complete healing, and the end-result is hardly better than that of the nonoperative treatment. The use of split-thickness skin grafts to completely cover the ulcer has much more to be said in its favor, for the healing time is thereby greatly shortened. The end-result is, however, only slightly

better than either the nonoperative, or the pinch-graft method of treatment, in its ability to withstand trauma.

Several months ago we began to observe several primary closures of small decubitus ulcers, by excision, undercutting and midline approximation in patients *en route* to other General Hospitals. Healing had occurred *per primam*, and the skin, with its normal subcutaneous padding, appeared quite normal. It seemed to us that closure by the use of sliding full-thickness grafts would be the ideal solution if it could be universally applied. Obviously, a simple linear closure could not be applied in the surgical treatment of the larger ulcers.² Could not these be primarily closed by some modification of this method? The skin from the iliac crest above, to the gluteal fold below and to the trochanters laterally, is fairly loose and free. The loss of subcutaneous fat and the atrophy of the glutei renders it even more so in our paraplegics. By the simple expedient of raising a full-thickness flap on each side of the ulcer, employing curvilinear incisions laterally along the iliac crest above, and the buttock below, we found it possible to rotate these flaps centripetally to cover even large defects. The extent of the surgery required to raise flaps sufficiently adequate to close the larger defects, was at first rather startling, and some of our earlier and larger ulcers were closed in two stages. With increasing experience in the placing of incisions to take full advantage of all the available adjacent loose skin, the number of our two-stage closures has rapidly diminished.

When is a patient ready for such an operation? Obviously, a debilitated or exhausted patient should not be subjected to such a major procedure, even if anesthesia is unnecessary. His healing power is poor, and he has little resistance against infection. First, the patient should be fully recovered from spinal shock. Second, he should exhibit a distinctly positive nitrogen balance for several weeks, as indicated by an improvement in strength and general well-being, a definite gain in weight, and local signs of healing. Third, the ulcer must be free from clinical signs of acute inflammation, its base covered with healthy granulation tissue free from sloughing fascia, and its margins fixed and circumscribed with invading epithelium. Cultures have been taken routinely, but only the presence of a *Streptococcus hemolyticus* or a *Staphylococcus aureus* (coagulase-positive) have deterred surgical intervention. The less pathogenic *Clostridia* and *B. pyocyaneus* have sometimes been inhabitants of these ulcers, but have been disregarded.

Preoperatively, the patient is given a high caloric, high protein diet supplemented with vitamins. Plasma, blood, and amino-acid infusions are used freely if indicated. As long as infection or sloughing tissue is present, daily gauze dressings moistened with penicillin solution, 250 units per cc. are used locally. Thereafter, simple fine-mesh gauze dressings impregnated with a little xeroform ointment are applied daily after dusting the granulations with plasma-penicillin powder.³

At operation, most of the patients require no anesthesia. The ulcer (Fig. 1) is completely excised, including the peripheral scar tissue, and if

TREATMENT OF DECUBITUS ULCER

contracted and bloodless, its granulation tissue base (Fig. 2). An attempt to approximate the lateral margins of the defect in a midline linear closure, even after extensive lateral undercutting, would be unsuccessful in the larger ulcers. By making curvilinear incisions on each side from the superior

FIG. 1

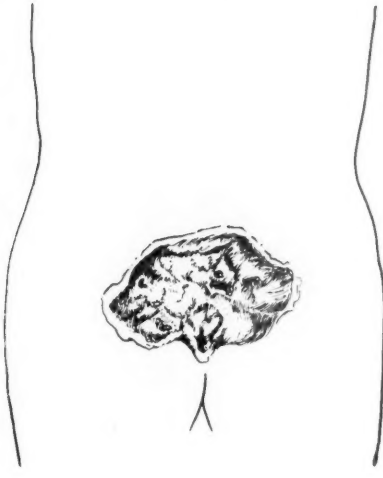


FIG. 2



FIG. 3

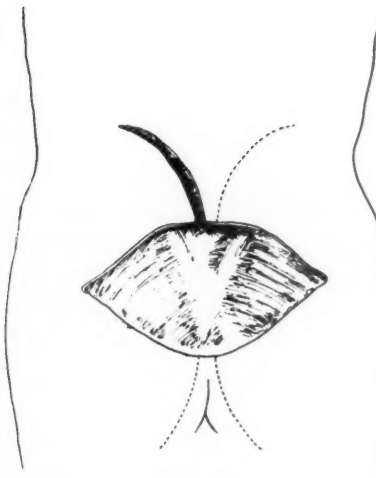
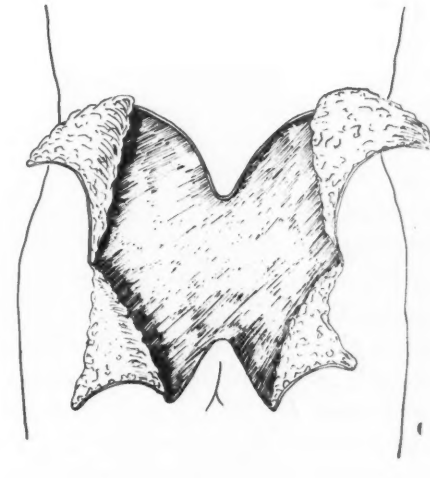


FIG. 4



- FIG. 1.—Preoperative appearance of a sacral ulcer.
FIG. 2.—The ulcer after excision of all peripheral scar tissue and its granulation tissue base.
FIG. 3.—Drawing showing position and extent of curvilinear incisions.
FIG. 4.—Drawing showing the four sector flaps completely dissected.

midline of the defect outward above the iliac crests and from the inferior midline outward and downward into the buttocks, two sector flaps are raised on each side, varying in size according to the shape of the defect (Figs. 3 and 4). The denuded area may now be closed by rotating the sector flaps of

each side toward each other horizontally and, finally, those of one side to those of the other (Figs. 5 and 6).

There are many details the observance of which seems to be essential to a successful outcome. Some of these embrace fundamental principles of good surgery—the excision of all scar tissue; the avoidance of trauma; meticulous hemostasis; the use of very fine nonabsorbable sutures; and

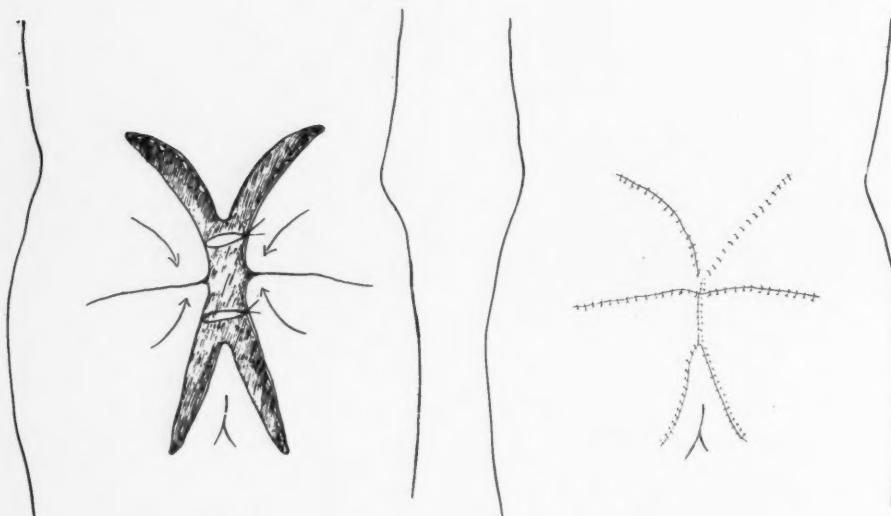


FIG. 5

FIG. 6

FIG. 5.—Drawing showing two sector flaps of each side already approximated, and ready for approximation to those of the other side.

FIG. 6.—Drawing showing final result following complete closure.

avoidance of tension. Others are peculiar to the region. The flaps are usually best developed in the plane overlying the deep fascial investment of the glutei where the least number of vessels are encountered. The subsection should be carried some distance lateral to the sacral origin of glutei, else a ridge of muscle will be raised on each side, lifting the medial portion of each approximated flap from the surface of the sacrum, and leaving a dead space for the accumulation of serum. For this reason, also, the lower sector raised from the buttock on each side should carry a rather thick layer of fat to reach the receding coccyx, after the flap is rotated upward and inward. Too much fat should not be left overlying the sacrum, since fatty tissue does not resist trauma well and its blood supply is poor. In making the superior curvilinear incisions, one should avoid the bony prominences of the posterior superior spines. Before closure, the entire wound should be thoroughly irrigated with physiologic saline solution, and, after final and complete hemostasis, a liberal amount of plasma-penicillin powder should be evenly distributed over the wound surfaces.

Postoperatively, we have used a pressure dressing, incorporating mechan-

TREATMENT OF DECUBITUS ULCER

ic's waste under an Ace bandage circularly applied about the lower trunk. If indicated by the presence in the preoperative culture of penicillin-sensitive organisms, penicillin is administered for four to five days after operation. Otherwise, sulfadiazine is administered.

FIG. 7

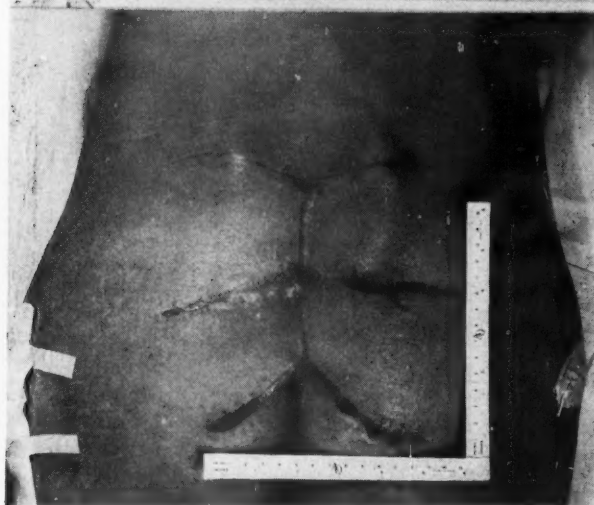
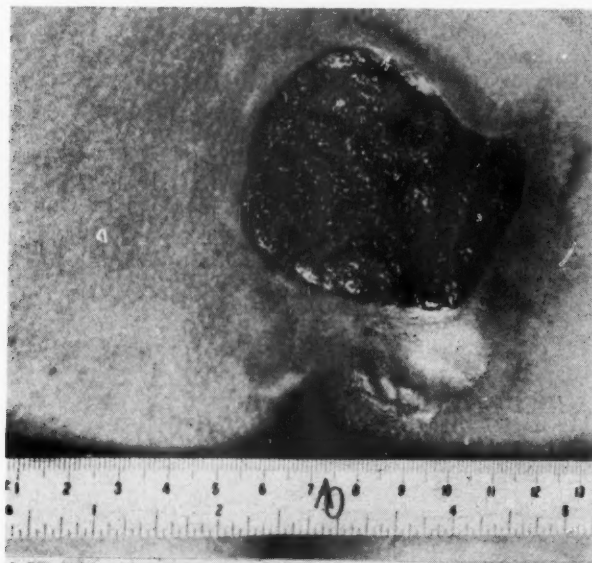


FIG. 8

FIG. 7.—Case 1: Preoperative appearance of sacral ulcer.

FIG. 8.—Case 1: Photograph of wound two months after operation.
Note battle wound of left lumbar region.

Postoperatively, the patient is placed in a Stryker frame four hours in the prone, and one-half hour in the supine position. Unless otherwise indicated, the dressing is not disturbed for five days, when alternate sutures are

removed. The remainder are removed in the next five days. The preoperative caloric and vitamin regimen is continued after operation. Within a month after operation, the patient is receiving the same care as the paraplegic patient without decubitus ulcer, *i.e.*, he alternates between the supine and prone position every two hours, sleeps in the usual army bed, with inner-spring mattress, and is allowed out of bed in a wheel chair.

REPORT OF CASES

Case 1

1. Date of injury: January 28, 1945.
2. Level of nerve injury: Cauda equina roots of L3 to S5, bilateral.
3. Probable date and circumstances of onset of ulcers: Patient sustained abdominal injuries requiring emergency celiotomy. Following operation he remained flat on his back for eight days. Bed linen was changed once daily. On February 7, 1945, ten days after injury, a large sacral decubitus ulcer was noted.
4. Size of ulcer before operation: 9 x 9.5 cm. (Fig. 7).
5. Laboratory data:

	Urinalysis	Plasma Protein
R.B.C., 3.6 million per cu. mm.	1+ albumen	7.9 Gm. per cent
Hb., 11.2 Gm. per cent.	Rare red blood cell	
Bacteriology:	Aerobic:	
	<i>A. aerogenes</i>	
	<i>B. proteus</i>	
	<i>Staphylococcus aureus hemolyticus</i>	
	<i>Staphylococcus albus</i>	

Anaerobic: No growth

6. Operation and Date: April 11, 1945: Anesthesia, endotracheal, nitrous oxide-ether. Excision and primary closure, all silk technic.

7. Postoperative Course: There was uneventful healing *per primam* except for a 1-cm. separation at the confluence of the four flaps. The wound was completely healed in three weeks. The patient was not allowed out of bed because of an osteomyelitis of the left sacro-iliac joint of traumatic etiology. There has been no secondary ulceration (Fig. 8).

Case 2

1. Date of injury: December 6, 1944.
2. Level of nerve injury: Seventh dorsal segment, complete.
3. Probable date and circumstances of onset of ulcer: Patient sustained a fracture dislocation of 7-8 D vertebrae, and blast injury to the lung. He was placed in an hyperextension encasement, and had pulmonary complications requiring the use of continuous oxygen therapy for several weeks. During this period, his condition was precarious. He was not turned to the prone position. On January 12, 1945, a sacral decubitus was well-developed.
4. Measurement of ulcer before operation: 6 x 5 cm. (Fig. 9).
5. Laboratory data:

	Urinalysis	Plasma Protein
R.B.C., 4.55 million per cu. mm.	2+ albumen	5.8 Gm. per cent
Hb., 12.7 Gm. per cent	5-10 red blood cells	
Bacteriology:	Aerobic:	
	<i>Ps. aeruginosa</i>	
	Anaerobic:	
	No growth	

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6. Operation: 1. March 23, 1945: Partial closure. No anesthesia. A central diamond-shaped defect approximately 4 cm. wide and 4 cm. long remained. 2. April 10, 1945: Secondary closure. No anesthesia.

FIG. 9

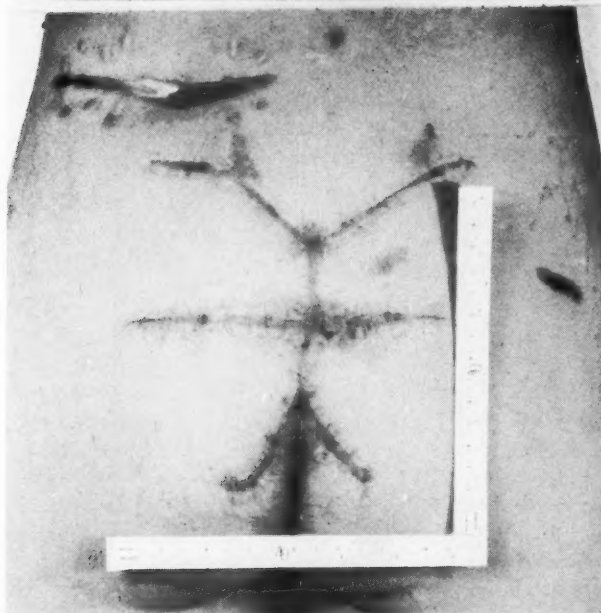
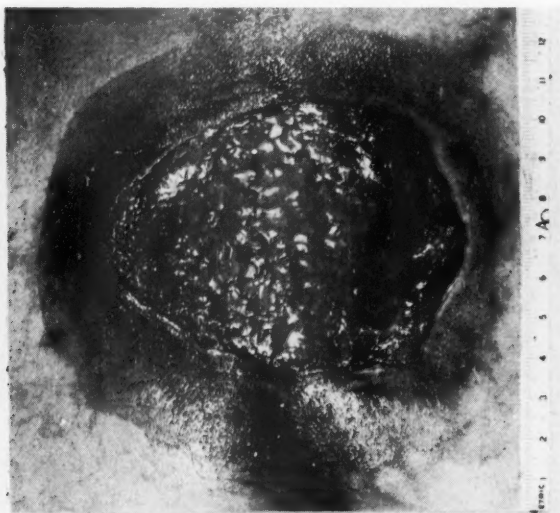


FIG. 10

FIG. 9.—Case 2: Preoperative appearance of sacral ulcer.

FIG. 10.—Case 2: Photograph of wound six weeks after closure.

7. Postoperative Course: The defect remaining after the first operation granulated cleanly. There was some separation of the suture lines at the margins of the defect. After the second operation the wound healed *per primam*. He was out of bed in about 35 days. There has been no secondary ulceration (Fig. 10).

Case 3

1. Date of injury: January 24, 1945.
2. Level of nerve injury: Fifth dorsal segment.
3. Probable date and circumstances of onset of ulcer: Following injury patient was passed rapidly through a chain of evacuations lasting two weeks, during which he remained on his back almost continuously, and usually on blanket litters. Ulcer first noted on February 10, 1945.

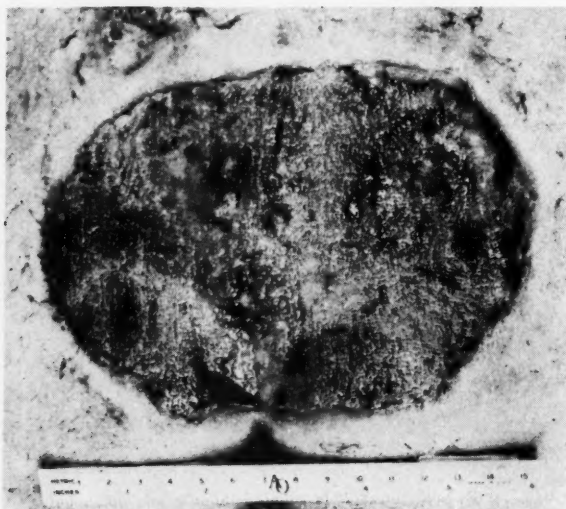


FIG. 11.—Case 3: Preoperative appearance of sacral ulcer.

4. Measurement of ulcer before operation: 15.5 cm. x 11 cm. (Fig. 11).
5. Laboratory data:

	Urinalysis	Plasma Protein
R.B.C., 3.89 million per cu. mm.	1+ albumen	7.5 Gm. per cent
Hb., 12.3 Gm. per cent		
Bacteriology:	Aerobic: <i>A. aerogenes</i> <i>Staphylococcus albus</i> , <i>Streptococcus nonhemolyticus</i> , <i>Ps. aeruginosa</i>	

Anaerobic: None

6. Operation: 1. April 6, 1945: Excision. Partial closure. T-shape, leaving 2.5-4 cm. midline defect along entire upright limb of T. Anesthesia: None. 2. April 19, 1945: Secondary closure, complete, no anesthesia.
7. Postoperative Course: The defect remaining after first operation granulated without infection. Healing occurred *per primam* after the second operation except for the appearance of a small seroma. The serum was aspirated and no infection supervened. Patient was out of bed in one month. There has been no recurrence of ulcer (Fig. 12).

Case 4

1. Date of injury: November 9, 1944.
2. Level of nerve injury: L2, complete.
3. Probable date and circumstances of onset of ulcer: Unknown. Patient had skin grafts on January 18 and 25, and February 14, 1945.
4. Measurement of ulcer before operation: 12.5 x 10 cm. (Figs. 13 and 14).
5. Laboratory data:

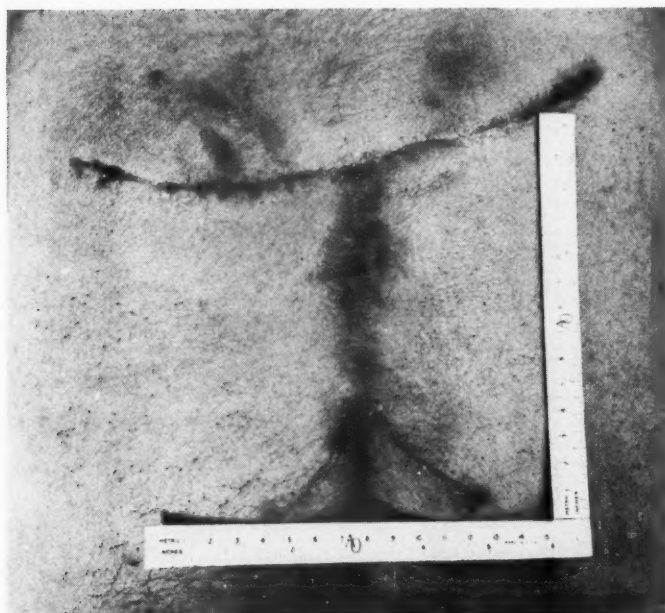


FIG. 12.—Case 3: Photograph five weeks after closure.

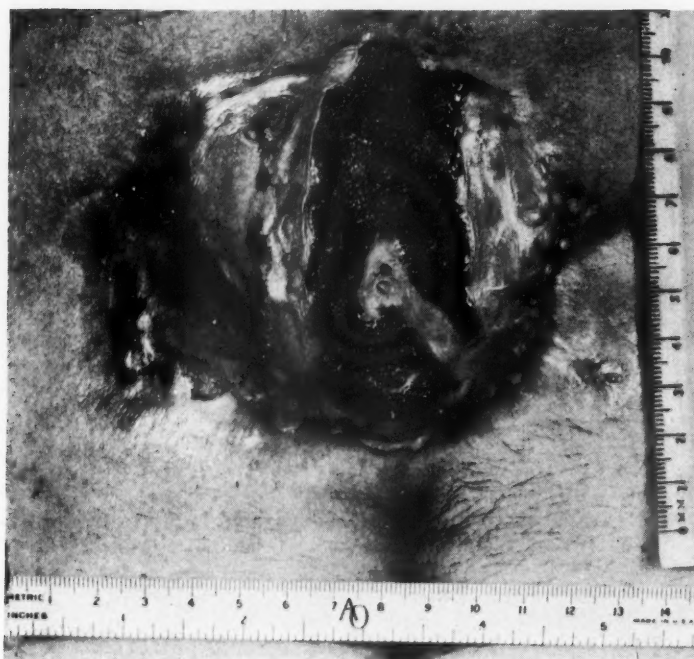


FIG. 13.—Case 4: Appearance of sacral ulcer five months after occurrence, in spite of Thiersch and pinch grafts.



FIG. 14.—Case 4: Photograph showing secondary ulcerations of grafted areas, despite good nursing care.

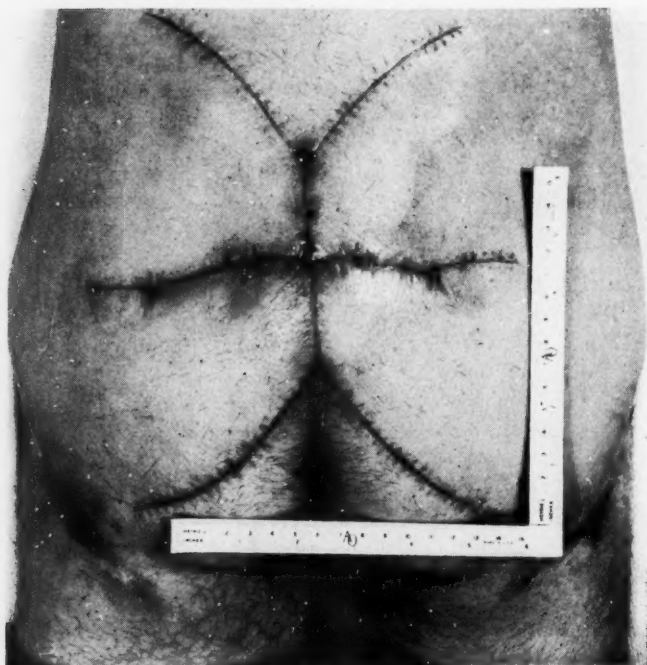


FIG. 15.—Case 4: Photograph two weeks after closure.

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	<i>Urinalysis</i>	<i>Plasma Protein</i>
R.B.C., 4.34 million per cu. mm.	1+ albumen	6.8 Gm. per cent
Hb., 12.7 Gm. per cent	Rare red blood cells	
Bacteriology:	Aerobic: <i>Ps. aeruginosa</i> <i>B. proteus</i> <i>Streptococcus nonhemolyticus</i>	
	Anaerobic: Negative	

6. Operation: May 17, 1945, primary closure under endotracheal inhalation anesthesia.

7. Postoperative Course: Uneventful primary healing occurred (Fig. 15). Three weeks after operation, following six hours continuous sitting on a wheel chair, a few small ulcerations developed under the inferior right flap. These are now healing and will not seriously impair the end-result.



FIG. 16.—Case 5: Preoperative appearance of sacral ulcer.

Case 5

1. Date of injury: December 30, 1944.
2. Level of nerve lesion: D12, complete.
3. Probable date and circumstances of onset of ulcer: Patient states that for the first eight to 12 days after injury he was continuously on his back on a blanket litter, without turning and without linen. The ulcer was first noted at the end of this period when he was transferred to an hospital ship.
4. Measurement of ulcer before operation: 14.5 x 14.5 cm. (Fig. 16).
5. Laboratory data:

	<i>Urinalysis</i>	<i>Plasma Protein</i>
R.B.C., 3.65 million per cu. mm.	1+ albumen	6.3 Gm. per cent
Hb., 11.2 Gm. per cent	8-10 white blood cells 2-3 red blood cells	

Bacteriology: Aerobic: *B. proteus*
 E. coli
 A. aerogenes
 Streptococcus nonhemolyticus
 Anaerobic: *Clostridium butyricum*

6. Operation: April 24, 1945, primary closure, without anesthesia.

7. Postoperative Course: Primary healing uneventful (Fig. 17). Patient was out of bed about one month after closure.

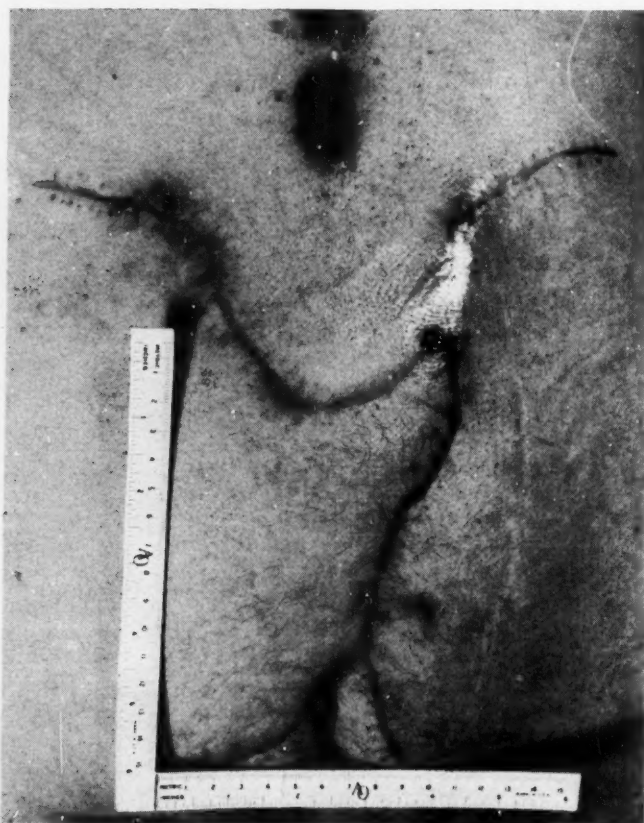


FIG. 17.—Case 5: Appearance one month after closure. Note small pressure sores over spinous processes, which were not operated upon.

Case 6

1. Date of injury: January 20, 1945.
2. Level of nerve injury: D5, complete.
3. Date and circumstances of onset of ulcer: Patient was placed in a body encasement following injury, and for the next two weeks was passed through a rapid chain of evacuations. During this period he was turned and his linen was changed infrequently. The ulcer was first noted on January 27, 1945.
4. The size of ulcer before operation: 12 x 17 cm. (Fig. 18).
5. Laboratory data:

R.B.C., 3.68 million per cu. mm.
 Hb., 11.2 Gm. per cent

Urinalysis
 1+ albumen
 Numerous white blood cells
 2-3 red blood cells

Plasma Protein
 7.5 Gm. per cent

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Bacteriology: Aerobic: *Ps. aeruginosa*
Aerobacter aerogenes
Streptococcus nonhemolyticus

Anaerobic: Negative

6. Operation: May 7, 1945, primary closure, without anesthesia.

7. Postoperative Course: There was an early slight flare about central suture lines which disappeared without suppuration in seven to eight days (Fig. 19). Patient is now out of bed.

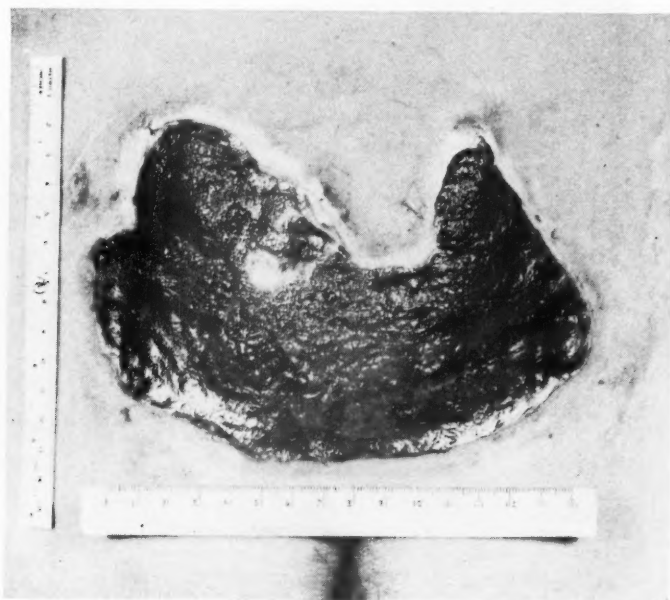


FIG. 18.—Case 6: Appearance of sacral ulcer before operation.

Case 7

1. Date of injury: February 1, 1945.
2. Level of nerve injury: D10, severe.
3. Date and circumstances of onset of ulcer: After injury, patient was not turned because of a fracture of the right shoulder. During the first week he remained on his back on blankets. A sacral decubitus was first noted on February 10, 1945.
4. Size of ulcer before operation: 9.5 x 9 cm. (Fig. 20).
5. Laboratory data:

	Urinalysis	Plasma Protein
R.B.C.	1+ albumen	7.6 Gm. per cent
Hb., 14.6 Gm. per cent	5-8 white blood cells	
Bacteriology: Aerobic:	<i>E. coli</i> <i>B. proteus</i> <i>Ps. aeruginosa</i> <i>Streptococcus nonhemolyticus</i> <i>Staphylococcus aureus nonhemolyticus</i> <i>Cl. butyricum</i>	

Anaerobic: None

nonhemolyticus, *Cl. butyricum*. Anaerobic: None.

5. Operation: May 3, 1945, primary closure under endotracheal inhalation anesthesia.

6. Postoperative Course: Primary healing occurred (Fig. 21). Patient was allowed out of bed in one month.

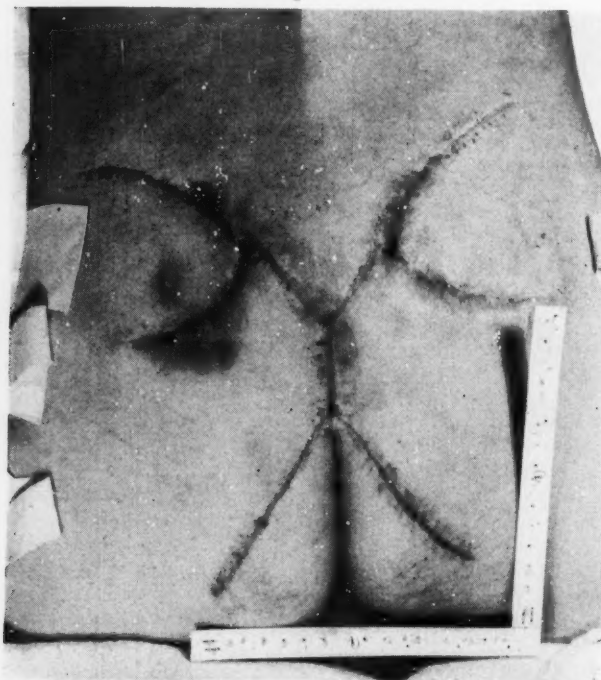


FIG. 19.—Case 6: Appearance three weeks after operation.

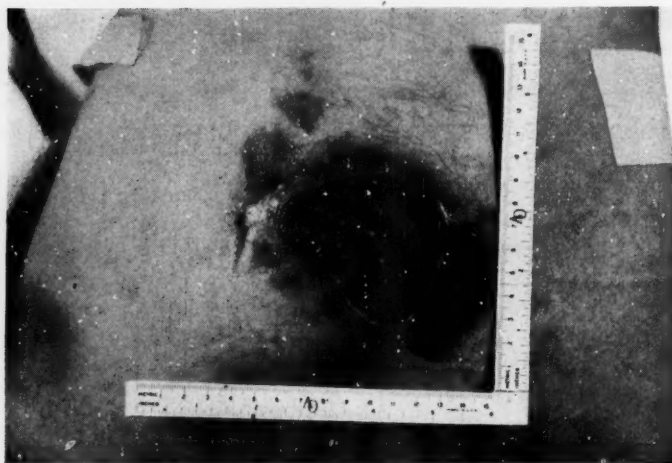


FIG. 20.—Case 7: Appearance of sacral ulcer before operation.

TREATMENT OF DECUBITUS ULCER

Case 8

1. Date of injury: February 9, 1945.
2. Level of nerve injury: 10D, complete.
3. Date and circumstances of onset of ulcer: During the first few days, patient states he was passed through a rapid chain of evacuations during which he was turned infrequently and there was little change of linen. A sacral decubitus was first noted on February 13, 1945.
4. Size of ulcer before operation: 13 x 11 cm. (Fig. 22).
5. Laboratory data:

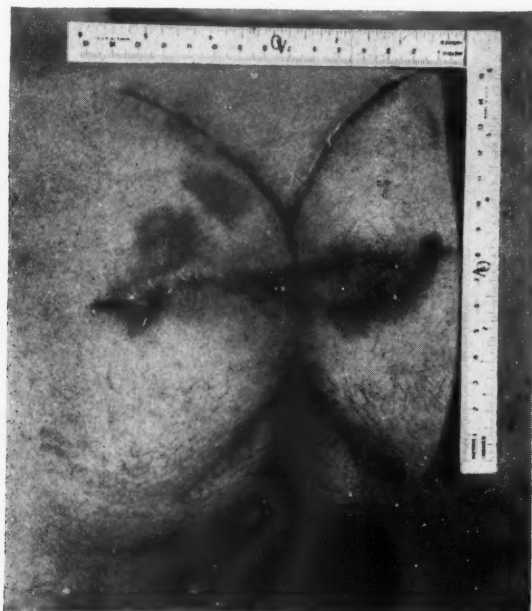


FIG. 21.—Case 7: Appearance one month after closure. Deeply pigmented areas were not excised.

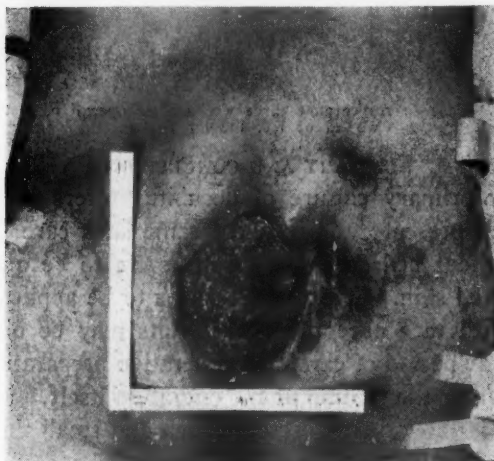


FIG. 22.—Case 8: Appearance of sacral ulcer before operation.

	Urinalysis	Plasma Protein
R.B.C., 4.57 million per cu. mm.	1+ albumen	6.2 Gm. per cent
Hb., 13.2 Gm. per cent		
Bacteriology:	Aerobic:	
	<i>E. coli</i>	
	<i>B. proteus</i>	
	<i>Streptococcus nonhemolyticus</i>	
	<i>Pseudomonas</i>	
	<i>Ps. aeruginosa</i>	
	Anaerobic:	
	<i>Clostridium septicum</i>	

6. Operation: May 9, 1945, primary closure, without anesthesia.

7. Postoperative Course: Primary healing occurred except for the accumulation of a little sterile serum beneath one of the flaps (Fig. 23). Patient was out of bed in one month.

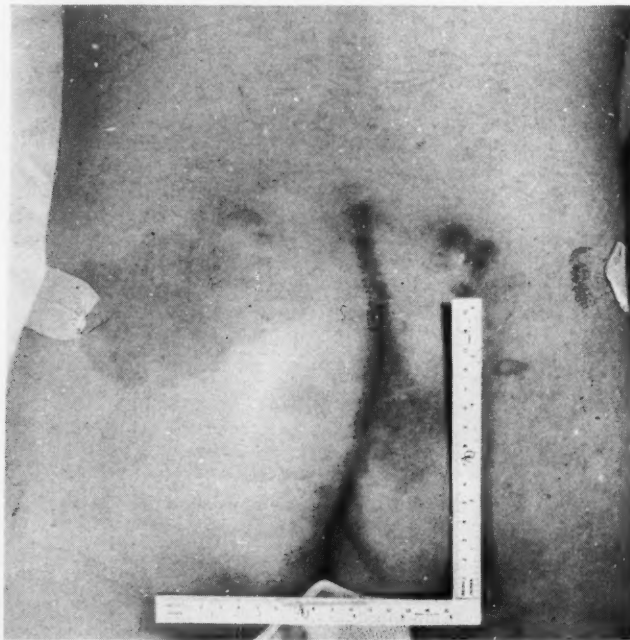


FIG. 23.—Case 8: Appearance three weeks after operation. Note battle wound of left lumbar region.

SUMMARY AND CONCLUSIONS

A method for primary closure of decubitus ulcers in young paraplegic casualties has been presented. Given the same back care postoperatively as the paraplegic without bed sore, the results seem to be quite as durable as the unbroken normal skin. The method seems to be applicable to the largest sacral ulcers. With rare exception, the results may be obtained by single-stage procedure. A period of careful preoperative preparation and evaluation is just as important as the technic of the operation itself.

Case 4 illustrates how unsatisfactory pinch and small thin Thiersch grafts may be. After repeated secondary ulcerations, the entire ulcer and scar were excised and the area covered with sliding full-thickness grafts.

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All the patients herein reported are now participating in a rehabilitation program intended to strengthen the upper part of the body for better mobilization, and are being educated in a gainful occupation.

Whether the method described is applicable to the sacral decubitus ulcer in older bed-ridden patients is problematic. The operation is a major plastic procedure and should not be attempted in a debilitated patient.

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THE RÔLE OF CHEMOTHERAPY IN WOUNDS AND SURGICAL INFECTIONS

I—CLINICAL AND BACTERIOLOGIC STUDIES*

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THE AUTHORS have, for the past two years, been jointly engaged in a study of the effect of bacteriostatics in fresh trauma and preëxisting infections under the National Research Council of Canada. The object of this investigation has been to determine as far as possible the practical value of bacteriostatics used topically or systemically, both prophylactically and therapeutically, in fresh trauma and preëxisting infections. The work has been done in civilian hospitals, and the laboratories of McGill University. A uniform surgical technic was adapted to the individual case so that the chief variables were the type of bacteriostatic and its method of application. Two types of condition were studied and these were further classified as described below. The accompanying tables carry out this same grouping.

A—*Fresh Trauma:*

1. Soft-tissue wounds of large size, including avulsion injuries and a few explosive and missile wounds, uncomplicated by injuries to blood vessels, nerves, tendons, joints, *etc.*
2. Wounds complicated by injuries to blood vessels, nerves, tendons, joints, *etc.*
3. Crushed hands and feet.
4. Traumatic amputations of arm and leg.
5. Compound fractures of long bones.
6. Burns—thermal, chemical, brush.
7. Missile wounds of soft-parts.

B—*Preëxisting Infections*—(all thus far studied have been pyogenic):

1. *Acute spreading* (with or without bacteriemia), such as osteomyelitis, severely infected wounds and burns, and spreading cellulitis of extremities with lymphatic involvement.
2. *Localizing and localized*, such as suppurative tenosynovitis, carbuncles, soft-tissue abscesses, suppurative adenitis, *etc.*
3. *Chronic infections*, such as traumatic osteitis, infected burns, leg ulcers, chronic osteomyelitis, *etc.*

* This work was carried out under the auspices of the National Research Council, Ottawa, Canada.

CHEMOTHERAPY IN INFECTIONS

BACTERIOSTATICS.—Most attention has been paid to sulfonamides and penicillin. These two materials have been employed both topically and systemically in more or less standardized fashion, as follows:

TOPICAL USE

1. *Sulfonamides.*—Sulfathiazole has been employed almost exclusively because of its solubility and relatively wide range of bacteriostatic action. When sensitivity has occurred, sulfadiazine has been substituted. When wounds were closed, sulfathiazole in a 10 per cent watery suspension has been introduced by spray in sufficient quantity to develop a good frosting throughout the wound and the excess allowed to spill over. Where wounds were packed, a 5 per cent oil-in-water emulsion "M. G. H. formula"* has been universally employed in abundant quantity.

2. *Penicillin.*—Both the calcium and sodium salts have been instilled in powder and solution for closed wounds and in a cream base "N. R. C. formula"† in concentration of 500 to 5,000 units per gram for packing purposes.

* Sulfathiazole Emulsion (M.G.H. formula)

R sulfathiazole	5%
triethanolamine	2%
distilled water	24%
white beeswax	5%
liquid paraffin	64%

† Penicillin Creams (N.R.C. formula)

R Z 2—stearic acid	15%
lanolin	8%
mineral oil	25%
water to	100%
carbitol	5%
R Z 9—stearic acid	10%
cetyl alcohol	5%
spermaceti	8%
lanolin	15%
water to	100%
glycerine	10%

SYSTEMIC USE

1. *Sulfonamides.*—While sulfathiazole was used in the early cases, our preference of late has been for sulfadiazine because it is better tolerated by the patients, and is an equivalent antibacteriostatic. The dosage by mouth averaged one gram four times daily, with larger doses the first day. The necessary care in alkalization and fluid intake has been observed. In a few cases where intravenous therapy has been necessary, a similar dosage has been maintained.

2. *Penicillin.*—Our practice has been to administer a minimum of 100,000 units daily by intravenous or intramuscular routes. The sodium salt has been used exclusively.

Latterly, the scope of the investigation was enlarged to include other materials, such as "BIPP," zinc peroxide, zephiran, certain organic acids, amino-acridenes, guanidine HCl, tyrothricin, diasone, *etc.*

Because of the popular demand for "controls," about a dozen cases were selected at random for surgery without bacteriostatics. Because some of

these cases did not fare so well clinically, it was decided to abandon the practice. The rest of the cases in this sense constitute controls of each other. About 250 cases have been included in this study. An equal number have been treated with similar clinical satisfaction, but insufficient data is available to justify their inclusion in the present discussion.

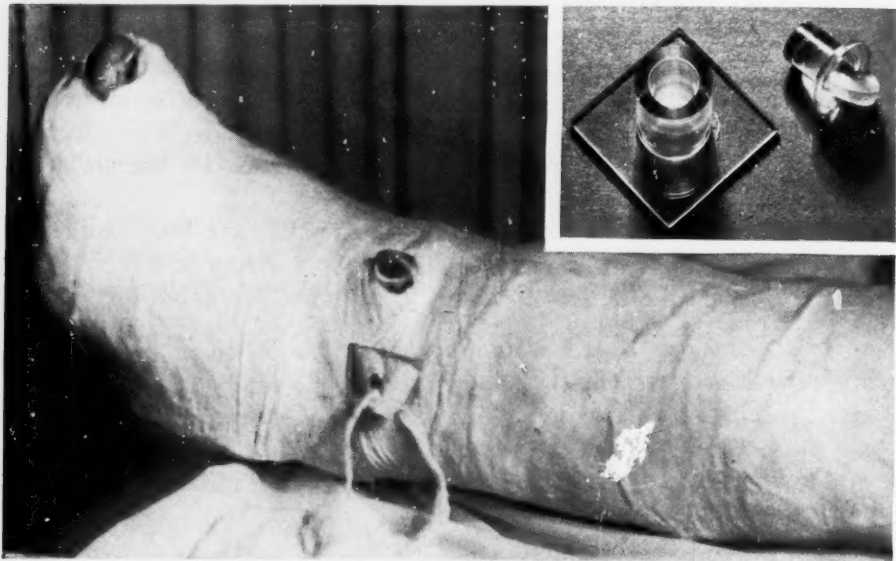


FIG. 1.—Surgical window of "Lucite" or "Perspex."

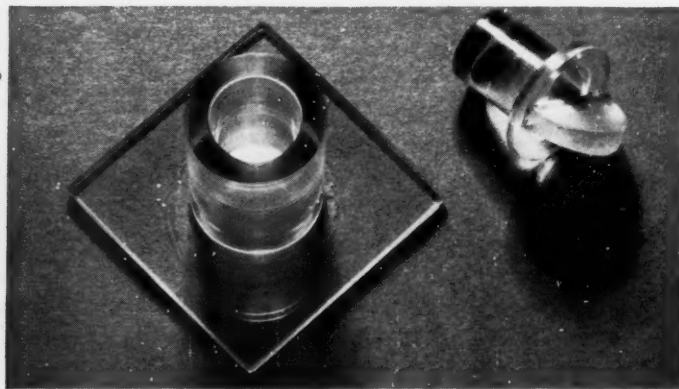


FIG. 2.—Surgical window *in situ*.

Appraisal has been carried out along two coördinated lines: A—Bacteriologic studies. B—Clinical observations.

A—*Bacteriologic studies* were done on all wounds and infections, before surgery, after surgery, and several times weekly through special windows of "Lucite" or "Perspex" (Figs. 1 and 2) and incorporated in the dressings, as well as at dressing changes. This technic has proved entirely satisfactory

as a practical method of acquiring bacteriologic information. We appreciate, as have others, the difficulties inherent in the surgical window technic for cultures. Dressings covering the wound may interfere with easy sampling. Cultures made from the area immediately under the window are not necessarily representative of the wound as a whole. These difficulties are to a large extent resolved, however, by the agreement between the cultures obtained through the window with those at dressing changes. In making cultures, sulfonamides were neutralized by para-amino-benzoic acid and penicillin by penicillinase.

B—*Clinical Observations.*—To facilitate these, a standard method of surgical approach was adopted, which, while observing the best known and approved surgical principles as outlined below, is flexible enough to be adaptable to all forms of trauma and infection met with. It has already been described in the literature,⁶ and it will suffice merely to enumerate the principles of the technic:

1. Delay of surgery until shock and hemorrhage are adequately controlled.
2. Surgical asepsis.
3. Preparatory washing with soap and water and copious saline lavage.
4. Adequate timing of initial surgery and subsequent surgical procedures.
5. Adequate surgery—initial and subsequent—including:
 - a. Excision of wound or infection—minimal, partial, maximal, often inadequately referred to as débridement.
 - b. Incision and counter-incision of wound or infection for relief and prevention of tension and for drainage.
 - c. Wound drainage by oily pack, referred to as "curtain drainage."
 - d. Suturing—*Primary suture* reserved for chest, head, face, joint, nerve and tendon cases.

Delayed primary as the general practice except in special cases. This is possible at any time during the first three weeks with revision of the wound.

Secondary suture at a later date, implying wound revision because of organizing granulation tissue.

N. B. All suturing was loosely done to prevent tension, with its inevitable risk of edema and danger of local bacterial multiplication.

Primary, delayed primary, and secondary split-skin grafting are terms employed with the same significance as applied to suturing.

6. Bacteriostasis.—From the foregoing, it will be seen that natural bacteriostasis is given full play. It is supplemented by bacteriostatics as innocuous as possible to the reacting tissues, free or fixed.

7. Compression—immobilization by massive occlusive compression dressings of the whole part. The large bulk of cotton waste gives uniformly distributed elastic compression. By this means, the vascular circulation is not impeded and is probably facilitated. Lymph stasis and edema are minimized, while in surface wounds and burns, plasma loss by wound oozing is lessened.

Moreover, the normal mechanism controlling capillary oozing is assisted. Light plaster encasement is added at times for additional immobilization, as in compound fractures of long bones. Internal fixation is done when necessary.

8. Timed infrequent change of dressings. Prevention of secondary infection is the keynote of infrequent dressing changes. This should mean not less than weekly and in long bone fractures at longer intervals, as required for callus formation. Dressings should never be removed for observation purposes. They should only be removed for definite reasons: to wit, for planned surgery, because the wound is healed, or in the rare occurrence of adverse signs and symptoms.

The following tables summarize all pertinent data relating to some 250 cases.

A key to the abbreviations is appended:

wnd.—wound
chr.—chronic
ac.—acute
comp.—compound
S.T.E.—sulfathiazole emulsion
S.D.E.—sulfadiazine emulsion
Pen. Cr.—penicillin cream
C.D.—compression dressing
P.C.D.—plaster-enclosed compression
dressing
D.P. suture—delayed primary suture
Sec. suture—secondary suture

AMPLIFYING COMMENT

A. *Fresh Trauma:*

1. *Large, uncomplicated soft-tissue wounds (20 cases including four controls):*

Delayed primary suture has been the practice in all of these. The initial surgery included wound excision, irrigation with 10 per cent sulfathiazole suspension, packing with bacteriostatic emulsion, and immobilization with occlusive compression dressing. None of the bacteriostatic-treated cases showed any evidence of clinical infection. There was a tendency for control cases to exhibit some pain, discomfort and fever, and for healing to be delayed up to twice the expected time.

2. *Wounds complicated by nerve, tendon, or joint injury (20 cases—no controls):*

Primary suture after irrigation with the bacteriostatic agent was practiced in all these. During the past year, sulfonamides or penicillin has been given systemically for prophylaxis. This group is the only one in which

primary suture was practiced, and this because it was felt justifiable to obtain the earliest possible function of tendon, nerve or joint, at small risk of infection. This occurred in two cases before prophylactic systemic bacteriostatics were used routinely, and two cases since.

3. *Crushed hands and feet and other complicated injuries (32 cases of crushed hands and feet, including 7 controls):*

The standard practice was delayed primary suture and/or graft with suitable treatment of small bone fractures. Infection occurred in only one control case and this was controlled, in turn, with systemic penicillin. Not a single instance of prolonged neurovascular sequelae was observed.

4. *Traumatic amputation of leg or arm (8 cases—no controls):*

The procedure was identical with No. 3. No infections occurred although in all of them, at one time or another, pyogenic organisms were present.

5. *Compound fractures of long bones (25 cases—no controls):*

Delayed primary or secondary suture was done as indicated after two to six weeks. This was a particularly interesting series without a single wound infection. All were dressed with sulfathiazole emulsion. Attention is drawn to the use of the Stader double-pin splint, incorporated in the first dressing, for better anatomic alignment with marked comminution or other difficulties.

6. *Burns—thermal, chemical, brush (45 cases—no controls):*

All but one were treated with sulfathiazole emulsion and compression dressings. There were 24 superficial and 21 deep burns requiring delayed primary or secondary split-skin grafting. In only a single instance was healing delayed by infection, and this by a preëxisting staphylococcal pyoderma. This was controlled by penicillin intramuscularly. Otherwise there were no infections.

7. *Missile wounds of soft-parts (8 cases—no controls):*

The usual practice was followed. Three buttock wounds showed some delay in healing from *B. proteus vulgaris* infections.

B. *Preëxisting Infections:*

1. *Acute spreading, with or without bacteriemia (no controls). (32 cases including acute osteomyelitis; spreading cellulitis; neglected burns; and suppurative tenosynovitis):*

Systemic bacteriostatics were employed until localization. All cases were then treated by incision and packing with a bacteriostatic agent and, when expedient, sutured or grafted after two to four weeks. Bacteriemia was treated by suitable systemic bacteriostatics as, for example, Cases 2 and 27 in Table B-1. Acute staphylococcal infections received penicillin intravenously and intramuscularly with equal success as, for example, Cases 14 and 18 in Table B-1. This group also included seven badly infected neglected burns, all of which were cured by topical application of sulfathiazole emulsion and one dressing.

TABLE A - 1 FRESH TRAUMA - LARGE UNCOMPLICATED SOFT TISSUE WOUNDS

NO.	TYPE OF INJURY	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAME	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAME	CLINICAL RESULTS
1.	LARGE AVULSION WOUND ARM	MAX. WOUND EXCISION PACK	CONTROL BASE	P.C.D.	STAPH. PYOGENES D. WELCHII	PERSIST 1ST CULTURE ONLY	D.P. SUTURE 11TH DAY	NONE		MORE THAN USUAL FEVER AND PAIN. LOOS- TAGE OF GRAFT. HEALED AT 5 WEEKS
2.	SEVERE LACERATION THIGH	MIN. WOUND EXCISION PACK	"	P.C.D.	STAPH. PYOGENES	DISAPPEAR GRADUALLY	D.P. SUTURE 15TH DAY	NONE		HEALED AT 4 WEEKS
3.	DEEP EMBRY WHEEL CUT THIGH	NONE	"	C.D.	NONE		DEFECT ALLOWED TO GRANULATE & FILL. SEC. SPLIT SKIN GRAFT AT 35 DAYS	NONE		HEALED AT 7 WEEKS
4.	LARGE SOFT TISSUE WOUNDS LEFT LEG	MIN. WOUND EXCISION PACK	S.T.E.	P.C.D.	STAPH. PYOGENES	PERSIST	D.P. SUTURE ON 14TH DAY	NONE		HEALED AT 4 WEEKS
5.	SEVERE SCALP LACERATION WITH LOSS OF LARGE FLAP	PARTIAL CLOSURE BY PLASTIC REPAIR SLITTING SCALP PACK	S.T.E.	P.C.D.	NONE		D.P. SUTURE ON 14TH DAY SLIDING SCALP. SEC. GRAFT 35TH DAY. FINAL EXCISION & REPAIR 65TH DAY.	NONE		HEALED AFTER EACH OPERATION RAPIDLY AND COMPLETE AT 10TH WEEK
6.	AVULSION INJURY DOORSH HAND WITH SEVERE INJURY	MIN. WOUND EXCISION PARTIAL PRIMARY SUTURE AND COVER TENDONS. PACK	S.T.E.	P.C.D.	NONE		D.P. SUTURE TO COMPLETE ON 16TH DAY	STAPH. PYOGEN.	PERSIST	HEALED AT 5 WEEKS FUNCTION AT 7 WEEKS
7.	SEVERE LACERATION OF SCALP WITH LOSS OF TISSUE	PRIMARY SUTURE ALL BUT SMALL AREA	S.T.E.	C.D.	NONE		NONE RE-DRESSED AT 1 WEEK	NONE		HEALED AT 10 DAYS
8.	STAB WOUND OF FOREARM	MIN. WOUND EXCISION PACK	S.T.E.	C.D.	WELCHII	PERSIST	NONE	NONE		HEALED AT 10 DAYS
9.	MULTIPLE SOFT TISSUE WOUNDS LEFT LEG	PARTIAL WOUND EXCISION PACK	S.T.E.	P.C.D.	NONE		D.P. SUTURE 16TH DAY	STAPH. PYOGEN. ON 10TH DAY ON 15TH DAY ON 20TH DAY		HEALED AT 4 WEEKS
10.	STAB WOUND OF ARM	WOUND EXCISION PACK	S.T.E.	C.D.	NONE		D.P. SUTURE AT 8 DAYS	NONE		HEALED AT 16 DAYS
11.	LACERATION OF LEG	WOUND EXCISION PACK	S.T.E.	C.D.	NONE		D.P. SUTURE AT 6 DAYS	STAPH. PYOGEN.	PERSIST	HEALED AT 20 DAYS
12.	STAB WOUNDS ARM AND CHEST	WOUND EXCISION PACK	S.T.E.	C.D.	NONE		D.P. SUTURE AT 7 DAYS	NONE		HEALED AT 16 DAYS
13.	LACERATION LEFT THIGH	WOUND EXCISION PACK	PER. CR.	C.D.	STAPH. PYOGENES	PERSIST	D.P. SUTURE AT 10 DAYS	NONE		HEALED AT 16 DAYS
14.	LACERATION RIGHT ARM	WOUND EXCISION PACK	PER. CR.	C.D.	NONE		D.P. SUTURE AT 4 DAYS	STAPH. PYOGEN.	PERSIST	HEALED AT 14 DAYS
15.	LARGE HEMATOMA THIGH FROM CRUSH INJURY	EVACUATION HEMATOMA (INCI- SION & EXCISION PACK)	S.T.E.	C.D.	NONE		D.P. SUTURE AT 10 DAYS	NONE		HEALED AT 20 DAYS
16.	LARGE LACERATIONS BOTH LEGS	WOUND EXCISION PACK	S.T.E.	C.D.	STAPH. PYOGENES	PERSIST	D.P. SUTURE AT 10 DAYS	NONE		HEALING DELAYED BY INFECTION 30 DAYS - MYXCEDEMA
17.	MULTIPLE SOFT TISSUE WOUNDS. LEFT LEG	WOUND EXCISION PACK	S.T.E.	C.D.	NONE		D.P. SUTURE AT 14 DAYS	STAPH. PYOGEN.	PERSIST	HEALED AT 26 DAYS
18.	LARGE HEMATOMA, HIP	WOUND INCISION & EXCISION	S.T.E.	C.D.	NONE		D.P. SUTURE AT 12 DAYS	NONE		HEALED AT 21 DAYS
19.	STAB WOUND BUTTOCK WITH HEMATOMA	EVACUATION OF HEMATOMA EXCISION	S.T.E.	C.D.	PROTEUS		D.P. SUTURE AT 10 DAYS	NONE		HEALING DELAYED 4 WEEKS
20.	LACERATION EVULSION LEG	WOUND EXC. PACK	CONTROL BASE	C.D.	PROTEUS		D.P. SUTURE AT 7 DAYS	STAPH. PYOGEN.	PERSIST	HEALING DELAYED 6 WEEKS

TABLE A - 2

FRESH TRAUMA

- WOUNDS COMPLICATED BY NERVE, TENDON AND JOINT INJURIES

NO.	TYPE OF INJURY	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	DATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
1.	LACERATION HAND DIVULSION FLEX. TENDONS	PRIM. SUTURE	SULFA SUSP.	P.C.D.	NONE		NONE	NONE		HEALED IN 3 WEEKS GOOD FUNCTION
2.	LACERATIONS WRIST DIVULSION FLEX. TENDONS	PRIM. SUTURE	SULFA SUSP.	P.C.D.	NONE		NONE	NONE		HEALED AT 4 WEEKS FUNCTION AT 6 WEEKS
3.	MULTI-LACERATIONS HAND & FINGERS DIVULSION 2 FLEX. TENDONS	PRIM. SUTURE TENDONS WOUND PACKED	SULFA SUSP. S.T.E.	P.C.D.			D.P. SUTURE WOUND AT 14 DAYS	NONE		HEALED AT 4 WEEKS FUNCTION AT 6 WEEKS
4.	LACERATIONS HAND AND ARM MULT. TENDON DIVULSION EXT. TENDONS	PRIM. SUTURE TENDONS WOUND PACKED	S.T.E.	P.C.D.	NONE		D.P. SUTURE AT 18 DAYS	NONE		HEALED AT 4 WEEKS FUNCTION AT 5 WEEKS
5.	LACERATIONS HAND DIVULSION EXT. TENDONS	PRIM. SUTURE TENDONS AND WOUND	SULFA SUSP.	P.C.D.	NONE		NONE	NONE		HEALED AT 3 WEEKS FUNCTION AT 6 WEEKS
6.	LACERATIONS FINGERS, DIVUL- SION 1 FLEX. TENDON	PRIM. SUTURE TENDON AND WOUND	SULFA SUSP.	P.C.D.	STAPH. PYOG. I CULTURE		NONE	NONE		HEALED AT 3 WEEKS GOOD FUNCTION
7.	LACERATIONS FINGERS DIVULSION 1 FLEX. TENDON	PRIM. SUTURE TENDON AND WOUND	SULFA SUSP.	P.C.D.	NONE		NONE	NONE		HEALED AT 3 WEEKS GOOD FUNCTION
8.	LACERATIONS FINGER, DIVULSION 1 FLEX. TENDON	PRIM. SUTURE TENDON AND WOUND	SULFA SUSP.	P.C.D.	NONE		NONE	NONE		HEALED AT 3 WEEKS GOOD FUNCTION
9.	LACERATION OF HAND, DIVULSION 1 FLEX. TENDON	PRIM. SUTURE	SULFA SUSP.	P.C.D.	STAPH. PYOG. I CULTURE		NONE	NONE		HEALED AT 3 WEEKS
10.	LACERATION FOREARM, DI- VULSION FLEX. TENDONS AND MEDIAN NERVE	WOUND EXCISION PRIMARY SUTURE	SULFA SUSP.	P.C.D.	NONE		NONE	NONE		HEALED AT 3 WEEKS GOOD FUNCTIONAL RECOVERY NERVE AND TENDON
11.	LACERATIONS FINGERS DIVUL- SION FLEX. TENDONS	WOUND EXCISION PRIMARY SUTURE	SULFA SUSP.	P.C.D.	NONE		NONE	NONE		HEALED AT 3 WEEKS
12.	LACERATIONS HAND DIVULSION FLEX. TENDONS FINGER	WOUND EXCISION PRIMARY SUTURE	SULFA SUSP.	P.C.D.	STAPH. PYOG.	PERSIST	NONE	NONE		HEALED AT 3 WEEKS
13.	LACERATION FINGERS DIVUL- SION FLEX. TENDONS	WOUND EXCISION PRIMARY SUTURE	SULFA SUSP.	P.C.D.	STAPH. PYOG.	PERSIST	INFECTION WOUND RE-OPENED AT 5 DAYS PACKED WITH S.T.E.SEC.SUTURE 3 WEEKS	AT OPER. STAPH. PYOG.	PERSIST	HEALING AFTER 5 WEEKS FUNCTION IMPAIRED
14.	LACERATION FINGERS DIVUL- SION FLEX. TENDONS	WOUND EXCISION PRIMARY SUTURE	SULFA SUSP.	P.C.D.	NONE		INFECTION WOUND RE-OPENED AND PACKED AT 6 DAYS WITH S.T.E.	STAPH. PYOG.	PERSIST	HEALING AFTER 6 WEEKS FUNCTION IMPAIRED
15.	LACERATIONS HAND DIVULSION EXT. TENDONS	WOUND EXCISION PRIMARY SUTURE	SULFA SUSP. ORALLY	P.C.D.	NONE		WOUND RE-OPENED AND PACKED AT 6 DAYS WITH S.T.E. S.E.C. SUTURE 4 WEEKS	STAPH. PYOG.	PERSIST	HEALING AFTER 6 WEEKS FUNCTION IMPAIRED
16.	FLEX. TENDONS FOREARM- LARGE LACERATIONS	WOUND EXCISION PRIMARY SUTURE	"	P.C.D.	NONE		NONE	NONE		HEALING AT 3 WEEKS
17.	LACERATIONS HAND DIVULSION FLEX. TENDONS	WOUND EXCISION PRIMARY SUTURE	"	P.C.D.	STAPH. PYOG. I CULTURE		NONE	NONE		HEALING AT 3 WEEKS
18.	LACERATION HAND DIVULSION TENDON	PRIMARY SUTURE	SULFA SUSP. OPEN INTRAM AFTER INFECTION	P.C.D.	NONE		WOUND INFECTION, OPENED AT 10 DAYS PACKED GISTITIS OF PHALANX	STAPH. PYOG.	PERSIST	DELAY IN HEALING 2 MONTHS POOR FUNCTION

TABLE A - 2 - FRESH TRAUMA - - WOUNDS COMPLICATED BY NERVE, TENDON AND JOINT INJURIES

NO.	TYPE OF INJURY	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHO- GENS	FATE OF SAFE	SURSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
19.	COMP. WOUND INTO KNEE JOINT	WOUND EXCISION PRIMARY SUTURE JOINT WOUND PACKED	SULFA SUSP. SULFA ORALLY	P.C.D.	NONE		D.P. SUTURE AT 21 DAYS	NONE		HEALED AT 30 DAYS
20.	LACERATION OF FOREARM FLEX. TENDONS & MEDIAN NERVE DI- VULSED	WOUND EXCISION PRIMARY SUTURE NERVE, TENDONS WOUND	SULFA SUSP. SULFA ORALLY	P.C.D.	STAPH. PYOG.	PERSIST	NONE	NONE		HEALED AT 3 WEEKS EXCELLENT NERVE AND TENDON FUNCTIONAL RECOVERY

TABLE A - 3 - CRUSH TRAUMA - - CRUSH HANDS & FEET

NO.	TYPE OF INJURY	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SURSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
1.	CRUSH FOOT-DEEP SPLIT WOUND	MIN. WND. EXCISION PACK	CONTROL BASE	P.C.D.	PTOCYA- NEUS	PERSIST	D.P. SUTURE 14TH DAY	NONE		HEALED AT 5 WKS
2.	CRUSH HAND, AMPUTATION ALL FOUR FINGERS	RE-AMP. DISARTICULATION AT META- CARP. JOINTS PACK	" "	P.C.D.	STAPH. PYOG.	DISAPPEAR GRADUALLY	D.P. SUTURE 15TH DAY	NONE		NONE PAIN AND FEVER THAN USUAL HEALED AT 9 WEEKS.
3.	CRUSH HAND, COMP. FRACT. 1ST METACARPAL, TENDON DIVULSED	PARTIAL WOUND EXCISION REDUC- TION. PACK	S.T.E.	P.C.D.	"	PERSIST	D.P. SUTURE 15TH DAY	NONE		HEALED AT 4 WEEKS FUNCTION AT 5 WEEKS
4.	CRUSH FOOT AMP. MALLUX	RE-AMP. PACK	S.T.E.	P.C.D.	WELCHII	PERSIST	D.P. SUTURE 20TH DAY	NONE		HEALED AT 6 WEEKS
5.	CRUSH HAND, PARTIAL AMP. 2 FINGERS	RE-AMP. PACK	S.T.E.	P.C.D.	NONE		D.P. SUTURE 14TH DAY	STAPH. PYOG.	PERSIST	HEALED AT 5 WEEKS FUNCTION AT 7 WEEKS
6.	SEVERE CRUSH HAND AND FINGERS PARTIAL AMP. OF 2 FINGERS	RE-AMP. FINGERS. PACK. MIN.	S.T.E.	P.C.D.	NONE		D.P. GRAFT AND SUTURE 16TH DAY	NONE		HEALED AT 5 WEEKS FUNCTION OF FOREFINGER IS POOR AT 8 WEEKS
7.	SEVERE CRUSH HAND DIVULSED TENDON AND FINGER	MIN. WND. EXCISION. PRIN. SUTURE, TENDON AND FINGER	S.T.E.	P.C.D.	NONE		D.P. GRAFT AND SUTURE 14TH DAY	NONE		HEALED AT 4 WEEKS
8.	CRUSH FOOT, LARGE SOFT TISSUE LACERATION SOLE, COMP. FRACTURE GREAT TOE	MIN. WND. EXCISION PACKS	PROFLA- VINE	P.C.D.	NONE		D.P. SUTURE 30TH DAY UNPAID WALKING P.P.C. 46TH DAY	STAPH. PYOG.	PERSIST	HEALED AT 6 WEEKS FUNCTION AT 10 WEEKS
9.	CRUSH HAND, COMP. FRACTURE FOREFINGER	MIN. WND. EXCISION PACK	S.T.P.P.	P.C.D.	STAPH. PYOG.	DISAPPEAR GRADUALLY	D.P. SUTURE 14TH DAY	NONE		HEALED AT 4 WEEKS FUNCTION AT 6 WEEKS
10.	CRUSH HAND, PARTIAL AMP. OF TWO FINGERS	RE-AMP. PARTIAL WOUND EXCISION. PACK	PEN.CR.	P.C.D.	NONE		D.P. SUTURE AND GRAFT 14TH DAY	NONE		HEALED AT 4 WEEKS FUNCTION AT 6 WEEKS
11.	CRUSH HAND, COMP. FRACTURE ALL FOUR METACARPALS DES- TRUCTION 4 TENDONS	PARTIAL WOUND EXCISION	PEN.CR.	P.C.D.	NONE		D.P. GRAFT 21ST DAY REPAIR TENDONS 42ND DAY	STAPH. PYOG.	PERSIST	HEALED AFTER BOTH OPER. GRAFT TOOK TAKE FUNCTION PARTIAL AT 10 WEEKS
12.	CRUSH FOOT COMP. FRACTURE TARSAL BONES. 2 LARGE WND LEFT HAND	MIN. WND. EXCISION REDUCTION - PACK	PEN.CR.	P.C.D.	NONE		D.P. SUTURE 14TH DAY. MOULDED UN- PAID WALKING P.P.C. ON 28TH DAY	NONE		HEALED AT 4 WEEKS FUNCTION AT 5 MONTHS
13.	CRUSH HAND, PARTIAL AMP.	RE-AMP. LEFT THIRD METACARPAL JOINT PACK	PEN.CR.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE ON 14TH DAY	NONE		HEALED AT 4 WEEKS TO HAVE PLASTIC
14.	CRUSH HAND, COMP. FRACTURE SOFT TISSUE WND. 3 FINGERS	RE-AMP. PACK	PEN.CR.	P.C.D.	NONE		D.P. SUTURE AND GRAFT 14TH DAY	STAPH. PYOG.	PERSIST	HEALED AT 4 WEEKS FUNCTION AT 6 WEEKS
15.	CRUSH FOOT COMP. FRACTURE PROX. PHALANX GREAT TOE	MIN. WND. EXCISION REDUCTION PACK	PEN.CR.	P.C.D.	STAPH. PYOG.	DISAPPEAR	D.P. SUTURE 14TH DAY	NONE		HEALED AT 4 WEEKS WALKING P.P.C. UNPAID

TABLE A - 3

FRESH TRAUMA

CRUSH HANDS & FEET

NO.	TYPE OF INJURY	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHO- GENS	FATE OF SAME	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAME	CLINICAL RESULTS
16.	CRUSH FOOT PARTIAL AMP.	RE-AMP. PACK	S.T.E.	P.C.D.	NONE		RE-AMP. AND D.P. SUTURE AT 14 DAYS	NONE		HEALED AT 3 WEEKS FUNCTION AT 5 WEEKS
17.	CRUSH HAND AMP. OF FINGER	RE-AMP. OF FINGER	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE AT 10 DAYS	NONE		HEALED AT 2 WEEKS FUNCTION AT 4 WEEKS
18.	CRUSH HAND, PARTIAL AMP. OF THUMB	EXCISION RE-AMP. THUMB. PACK	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE AND GRAFT AT 12 DAYS	NONE		HEALED AT 3 WEEKS TO HAVE PLASTIC RECONSTRUCT.
19.	CRUSH HAND, ROLLER INJURY DORSAL FLAP	PARTIAL EXCISION PART. SUTURE	S.T.E.	C.D.	"	PERSIST	D.P. SUTURE AT 14 DAYS	NONE		HEALED COMPLETELY 28 DAYS NORMAL FUNCTION 6 WEEKS
20.	CRUSH HAND, WITH COMP. FRACT. 1ST AND 2ND FINGERS	WMD. EXCISION PARTIAL RE-AMP. PACK	S.T.E.	P.C.D.	"	PERSIST	D.P. SUTURE AT 1 WEEK	NONE		HEALED AT 2 WEEKS - FUNCTION AT 6 WEEKS
21.	CRUSH HAND, WITH COMP. FRACT. THUMB AND SEVERED LONG FLEX. TENDON	WMD. EXCISION TENDON SUTURE PACK	S.T.E.	P.C.D.	NONE		D.P. SUTURE-AT 10 DAYS	NONE		HEALED AT 21 DAYS - FUNCTION AT 6 WEEKS
22.	CRUSH HAND, AMP. FOREFINGER	DISARTICULATE FINGER PACK	S.T.E.	P.C.D.	NONE		D.P. SUTURE AT 5 DAYS	STAPH. PYOG.	PERSIST	HEALED AT 18 DAYS - FUNCTION AT 4 WEEKS
23.	CRUSH HAND, PARTIAL AMP. FOREFINGER	RE-AMP. FINGER PACK	S.T.E.	C.D.	STAPH. PYOG.	DISAPPEAR IN 4 DAYS	D.P. SUTURE AT 4 DAYS			HEALED AT 19 DAYS - FUNCTION AT 5 WEEKS
24.	CRUSH HAND, PARTIAL AMP. FOREFINGER	RE-AMP. FINGER PACK	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE AT 5 DAYS	NONE		HEALED AT 10 DAYS - FUNCTION AT 4 WEEKS
25.	CRUSH HAND, SEVERE AMP. FOUR FINGERS	RE-AMP. PACK	S.T.E.	P.C.D.	"	PERSIST	D.P. SUTURE AT 8 DAYS	NONE		HEALED AT 3 WEEKS - FUNCTION AT 6 WEEKS
26.	CRUSH FOOT AND LEG	EXCISION PACK	CONTROL BASE	P.C.D.	"	PERSIST	D.P. SUTURE AT 7 DAYS	NONE		DELAY IN HEALING & REQUIRED 3RD RE-DRESSING AT 17 DAYS HEALED AT 31 DAYS - FUNCTION AT 2 MONTHS
27.	CRUSH HAND AND WRIST LACERATIONS PALM PART. AMP. 4TH FINGER	EXCISION RE-AMP. FINGER. PACK	CONTROL BASE	P.C.D.	NONE		D.P. SUTURE AT 6 DAYS	STAPH. PYOG.	PERSIST	HEALED AT 20 DAYS FUNCTION AT 4 WEEKS
28.	CRUSH HAND PARTIAL AMP. 3RD, 4TH AND 5TH FINGERS	EXCISION RE-AMP. PACK	CONTROL BASE	C.D.	NONE		D.P. SUTURE AT 4 DAYS	NONE		HEALED AT 16 DAYS - FUNCTION AT 3 WEEKS
29.	CRUSH HAND, AVULSION COMP. FRACTURE 4 METACARPALS	EXCISION PACK. PENICILLIN INTRAMUSC.	CONTROL BASE	P.C.D.	STAPH. PYOG. WELCHII	PERSIST	D.P. SUTURE AND GRAFT 6 DAYS	STAPH. INFECTION		DEVELOPED SPREADING INFECTION IN HAND WITH STAPH. DELAY IN HEALING REQ. PENICILLIN 1 WEEK
30.	CRUSH HAND, COMP. FRACTURE 4 METACARPALS PARTIAL TENDONS DIVULSION	EXCISION PACK.	S.T.E.	P.C.D.	NONE		D.P. GRAFT 12 DAYS	STAPH. PYOG.	PERSIST	HEALED AT 4 WEEKS - FUNCTION AT 6 MONTHS
31.	CRUSH HAND, COMP. FRACTURE THUMB & METACARPAL	EXCISION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 14 DAYS	NONE		HEALED AT 3 WEEKS - FUNCTION AT 5 WEEKS
32.	CRUSH HAND, COMP. FRACTURE THUMB	EXCISION PACK	CONTROL BASE	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 12 DAYS	NONE		HEALED AT 4 WEEKS - FUNCTION AT 7 WEEKS

TABLE A - 4

FRESH TRAUMA

AMPUTATIONS - TRAUMATIC

NO.	TYPE OF INJURY	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHO- GENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
1.	TRAIN ACCIDENT. AMPUTATION BOTH LEGS IN MIDDLE THIRD SEVERE HAEMORRHAGE AND SHOCK	AFTER 6 HOURS ANTI-SHOCK TREATMENT. OPEN RE-AMP. 3" BELOW KNEE. PACK.	S.T.E.	P.C.D. SPICA	NONE		D.P. SUTURE & GRAFT 19TH DAY	STAPH. PYOG.	PERSIST	HEALED AT 5 WEEKS - FUNCTION WITH PROTHESIS AT 4 MONTHS
2.	LARGE AVULSION WND. THIGH AND LEG DES- TROYS FEMORAL VESSELS. SEVERE HAEMORRHAGE AND SHOCK	AFTER 6 HOURS ANTI-SHOCK TREATMENT LIGATION VESSELS ONLY. AFTER 48 HOURS WND-EXCISION. OPEN RE-AMP. LOWER 1/3 THIGH	S.T.E. S.T.E.	P.C.D. P.C.D. SPICA	STAPH. PYOG.	PERSIST	D.P. SUTURE & GRAFT 18TH DAY	NONE		HEALED AT 4 WEEKS - FUNCTION WITH PROTHESIS AT 4 MONTHS
3.	MACHINE CRUSH LOWER LEG AND ANKLE COMPOUNDING JOINT. MODERATE HAEMORRHAGE AND SHOCK	AFTER 6 HOURS ANTI-SHOCK TREATMENT. WND. EXCISION OPEN RE-AMP. LEG. PACK	S.T.E.	P.C.D.	STAPH. PYOG. COLI	PERSIST PERSIST	D.P. SUTURE 17TH DAY	NONE		HEALED AT 4 WEEKS - FUNCTION WITH PROTHESIS AT 10 WEEKS
4.	TRAIN ACCIDENT. AMPUTATING LEG IN LOWER 1/3. SEVERE HAEMORRHAGE AND SHOCK	AFTER 7 HOURS ANTI-SHOCK TREATMENT. WND EXCISION OPEN RE-AMP. LEG. PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 18 DAYS	NONE		HEALED AT 4 WEEKS - FUNCTION WITH PROTHESIS AT 9 WEEKS
5.	MACHINE CRUSH WITH COMPOUND FRACTURE, DISLOCATION LOWER 1/2 OF LEG AND ANKLE. SEVERE HAEMORRHAGE AND SHOCK	AFTER 8 HOURS ANTI-SHOCK TREATMENT. WND EXCISION OPEN RE-AMP. LEG. PACK	S.T.E.	P.C.D.	STAPH. PYOG. PROTEUS	PERSIST DISAPPEAR 10TH DAY	D.P. SUTURE 19TH DAY	NONE		HEALED AT 5 WEEKS - FUNCTION WITH PROTHESIS AT 10 WEEKS
6.	MACHINE CRUSH HAND AND WRIST. MOD. HAEMORRHAGE AND SHOCK	AFTER 6 HOURS ANTI-SHOCK TREATMENT. WND EXCISION OPEN RE-AMP. FOREARM PACK	PEN.CR.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 12TH DAY	NONE		HEALED AT 3 WEEKS - FUNCTION WITH KESSLER PROTHESIS IN PROCESS
7.	MOTORCYCLE ACCIDENT INVOLVING LOWER LEG AND ANKLE. COMPOUND FRACTURES. MOD. HAEMORRHAGE AND SHOCK	AFTER 8 HOURS ANTI-SHOCK TREATMENT. WND EXCISION OPEN RE-AMP. LEG. PACK	S.T.E.	P.C.D.	STREP. PYOG. & COLI	DISAPPEAR 3RD DAY DISAPPEAR 12TH DAY	D.P. SUTURE 20TH DAY	STAPH. PYOG.	PERSIST	HEALED AT 5 WEEKS - FUNCTION AT 3 MONTHS WITH PROTHESIS
8.	LARGE AVULSION WND LEG WITH DESTRUC- TION OF CIRCULATION AND ANKLE JOINT MOD. HAEMORRHAGE AND SHOCK	AFTER 4 HOURS ANTI-SHOCK TREATMENT OPEN RE-AMP. AT SITE OF ELECTION	S.T.E.	P.C.D.	NONE		D.P. SUTURE 18 TH DAY	"	PERSIST	HEALED AT 4 WEEKS - FUNCTION WITH PROTHESIS AT 3 MONTHS

TABLE A - 5

FRESH TRAUMA

COMPOUND FRACTURES - ARM AND LEG

NO.	TYPE OF INJURY	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
1.	BOTH BONES RT. LEG SOFT TISSUE WND. LT. INTERNAL INJURIES FRACT. RIBS, PELVIS, RADIUS, CLAVICLE	WND. EXCISION REDUCTION PACK	S.T.E.	P.C.D.	LEFT LEG PYOCYANUS 3RD RT. LEG NONE	DISAP. 3RD DAY	D.P. SUTURE 16 DAYS	LT. STAPH PYOG. RT. "	PERSIST PERSIST	HEALED AT 4 WEEKS. THEN UNPADDED CAST - FUNCTION AT 7 1/2 MONTHS
2.	RIGHT HUMERUS	PARTIAL EXCISION REDUCTION PACK	S.T.E.	P.C.D.	NONE	NONE	SEC. SUTURE 4 WEEKS	NONE		HEALED AT 6 WEEKS - FUNCTION AT 3 MONTHS
3.	BOTH BONES RT. LEG. SOFT TISSUE WND. LT.	PARTIAL EXCISION. REDUCTION PACK	S.T.E.	P.C.D.	STAPH. PYOG. RT. LT.	PERSIST DISAPPEAR	SEC. SUTURE 4 WEEKS	NONE		HEALED AT 6 WEEKS - FUNCTION AT 5 MONTHS
4.	BOTH BONES LT. LEG	MIN. EXCISION	S.T.E.	P.C.D.	NONE	NONE	D.P. SUTURE 16 DAYS	STAPH. PYOG.	PERSIST	HEALED AT 4 WEEKS - FUNCTION AT 6 MONTHS

NO.	BOTH BONES LT. LEG	MIN. EXCISION	S.T.E.	P.C.D.	NONE	NONE	D.P. SUTURE 16 DAYS	STAPH. PYOG.	PERSIST AT 4 WEEKS - FUNCTION AT 6 MONTHS
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TABLE A - 5 FRESH TRAUMA - COMPOUND FRACTURES - ARM AND LEG *

NO.	DIAGNOSIS	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
5.	BOTH BONES LEFT FOREARM LARGE SOFT TISSUE WIND AND DESTRUCTION MUSCLE AND TENDONS	EXTENSIVE WIND EXCISION REDUCTION PACK	S.T.E.	P.C.D.	STREP. VIR.	PERSIST 4 WEEKS	SEC. SUTURE AND SPLIT GRAFT, 6 WEEKS	NONE		HEALED AT 9 WEEKS - FUNCTION AT 6 MONTHS
6.	BOTH BONES RIGHT FOREARM LARGE SOFT TISSUE WIND AND DESTRUCTION MUSCLE AND TENDONS	EXTENSIVE WIND EXCISION REDUCTION PACK	S.T.E.	P.C.D.	NONE		SEC. SUTURE AND SPLIT GRAFT 4 WEEKS	STAPH. PYOG.	PERSIST	HEALED AT 6 WEEKS - FUNCTION AT 6 MONTHS
7.	BOTH BONES LEFT LEG	PARTIAL WOUND EXCISION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE AT 17TH DAY	NONE		HEALED AT 6 WEEKS - FUNCTION AT 7 MONTHS
8.	BOTH BONES RIGHT LEG **	WIND EXCISION STADER SPLINT IN DRESSING	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 14TH DAY	NONE		HEALED AT 4 WEEKS - FUNCTION AT 6 MONTHS
9.	BOTH BONES RIGHT FOREARM **	EXTENSIVE WIND EXCISION STADER SPLINT IN DRESSING	S.T.E.	P.C.D.	NONE		D.P. SUTURE 20TH DAY	STAPH PYOG.	PERSIST	HEALED AT 5 WEEKS - FUNCTION AT 7½ MONTHS
10.	BOTH BONES LEFT LEG	PARTIAL WIND EXCISION	S.T.E.	P.C.D.	NONE		D.P. SUTURE 14TH DAY	STAPH PYOG.	PERSIST	HEALED AT 4 WEEKS - FUNCTION AT 8 MONTHS
11.	BOTH BONES RIGHT LEG	MIN. WIND EXCISION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 14TH DAY	NONE		HEALED AT 4 WEEKS - FUNCTION AT 6 MONTHS
12.	BOTH BONES LEFT LEG. LOSS OF ** EXT. TENDONS	EXTENSIVE WIND EXCISION PACK	S.T.E.	P.C.D.	PROTEUS	PERSIST PERSIST	D.P. SUTURE 18TH DAY	NONE		HEALED AT 4 WEEKS - FUNCTION AT 6 MONTHS
13.	BOTH BONES RT. LEG **	WIND EXCISION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 17TH DAY	NONE		HEALED AT 4 WEEKS - FUNCTION AT 4 MONTHS (CHILD)
14.	BOTH BONES RT. FOREARM	WIND EXCISION PACK	S.T.E.	P.C.D.	NONE		D.P. SUTURE 21ST DAY	STAPH. PYOG.	PERSIST	HEALED AT 6 WEEKS - FUNCTION AT 3 MONTHS (CHILD)
15.	BOTH BONES RT. LEG. LARGE SOFT TISSUE WINDS	EXTENSIVE WIND EXCISION REDUCTION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 21ST DAY	NONE		HEALED AT 5 WEEKS - FUNCTION AT 4 MONTHS (CHILD)
16.	RT. HUMERUS INTO ELBOW JOINT ** LARGE SOFT TISSUE WOUND	IMPOSSIBLE TO GLOBE JOINT WIND EXCISED, PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	SEC. SUTURE 28TH DAY	NONE		HEALED AT 6 WEEKS - FUNCTION ONLY PARTIAL AT 4 MONTHS
17.	BOTH BONES LEFT LEG	WIND EXCISION REDUCTION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 21ST DAY	PROTEUS- NEUS	PERSIST	HEALED AT 5 WEEKS - FUNCTION AT 4 MONTHS (CHILD)
18.	TARSAL BONES AND ANKLE JOINT	WIND EXCISION REDUCTION PACK	S.T.E.	P.C.D.	"	PERSIST	D.P. SUTURE 12TH DAY	NONE		HEALED AT 3 WEEKS - FUNCTION AT 6 MONTHS
19.	FEMUR LOWER THIRD LACERATION OF KNEE JOINT	EXCISION REDUC. STADER SPLINT IN DRESSING, SUTURE KNEE JOINT. WIND. PACKED	S.T.E.	P.C.D.	NONE		SEC. SUTURE 6TH WEEK	WELCH I	PERSIST	HEALED AT 8 WEEKS - FUNCTION - STILL IN PLASTER AT 3 MONTHS
20.	HUMERUS RIGHT	WIND EXCISION REDUCTION PACK	S.T.E.	P.C.D.	NONE		SEC. SUTURE 25TH DAY	PROTEUS	DISAPPEAR AFT. 4 DAYS	HEALED AT 6 WEEKS - FUNCTION AT 8 WEEKS
21.	LEFT TIBIA ONLY **	WOUND EXCISION REDUCTION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE 21ST DAY	NONE		HEALED AT 5 WEEKS - FUNCTION AT 5 MONTHS
22.	TARSAL BONES	WIND EXCISION REDUCTION PACK	S.T.E.	P.C.D.	PROTEUS	PERSIST	D.P. SUTURE 14TH DAY	NONE		HEALED AT 4 WEEKS - FUNCTION AT 6 MONTHS

* MANY CASES CONTINUED

** EXTENSIVE COMMINUTION REQUIRING DOUBLE PIN FIXATION

TABLE A - 5

FRESH TRAUMA

COMPOUND FRACTURES - ARM AND LEG *

NO.	DIAGNOSIS	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
23.	BOTH BONES, LT. LEG	WIND-EXCISION REDUCTION PACK	S.T.E.	P.C.D.	NONE	PERSIST	D.P. SUTURE 28TH DAY	PYOCYANEUS	PERSIST	HEALED AT 6 WEEKS - FUNCTION AT 7 MONTHS
24.	BOTH BONES, RT. LEG **	WIND EXCISION WIRED	S.T.E.	P.C.D.	STAPH.PYOG.	PERSIST	D.P. SUTURE 14TH DAY	NONE		HEALED AT 4 WEEKS - FUNCTION AT 6 MONTHS
25.	COMP. FRACT. TARSAL BONES ** & ANKLE JOINT	WIND EXCISION, PACK	S.T.E.	P.C.D.	NONE		D.P. SUTURE 24TH DAY	STAPH.PYOG.	PERSIST	HEALED AT 4 WEEKS - FUNCTION AT 3 MONTHS

* MANY CASES CONTINUED

** EXTENSIVE COMMUNION REQUIRING DOUBLE PIN FIXATION

TABLE A - 6

FRESH TRAUMA

- BURNS

NO.	TYPE OF BURN AND AREA	SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SECONDARY TREATMENT	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
1.	DEEP BURNS 18%	MECHANICAL CLEANSING & WASHING WITH SOAP & WATER	S.T.E.	C.D.	STAPH. PYOG. STREP. PYOG. A	PERSIST DISAPPEAR	SPLIT SKIN GRAFT 3, 5, & 7 WEEKS			PRIMARY HEALING ALL GRAFTS
2.	" " " 10%	"	S.T.E.	C.D.	NONE		SPLIT SKIN GRAFT 17TH DAY	STAPH. PYOG.	PERSIST	PRIMARY HEALING OF GRAFT
3.	" " " 10%	"	S.T.E.	C.D.	PROTEUS	PERSIST	SPLIT SKIN GRAFT 20TH DAY	PROTEUS		PARTIAL HEALING INFECTION RE-GRAFTED SUCCESSFULLY AFTER 3 WEEKS
4.	" " " 15%	"	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	" " " 20TH DAY	NONE		PRIMARY HEALING OF GRAFT
5.	" " " 20%	"	S.T.E.	C.D.	NONE		" " " 28TH DAY	NONE		PRIMARY HEALING OF GRAFT
6.	" " " 25%	"	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	" " " 24TH DAY	NONE		PRIMARY HEALING OF GRAFT
7.	" " " 15%	"	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	" " " 11TH DAY	NONE		PRIMARY HEALING OF GRAFT
8.	" " " 10%	"	S.T.E.	C.D.	STAPH. PYOG.	AT GRAFT ONLY	" " " 14TH DAY	NONE		PRIMARY HEALING OF GRAFT
9.	" " " 25%	"	S.T.E.	C.D.	STAPH. PYOG.		" " " 15TH DAY	NONE		PRIMARY HEALING OF GRAFT
10.	" " " 5%	"	S.T.E.	C.D.	STAPH. PYOG.		NONE - HEALED IN 10 DAYS	NONE		PRIMARY HEALING
11.	" " " 5%	"	PEN. CR.	C.D.	NONE		NONE - HEALED IN 12 DAYS	STAPH. PYOG.	PERSIST	PRIMARY HEALING
12.	" " " 55%	"	S.T.E.	C.D.	STAPH. PYOG. PROTEUS	PERSIST DISAPPEAR	DRESSED FORTNIGHTLY WITH SPLIT SKIN GRAFTING AT EACH OF 5 RE-DRESSINGS	NONE	PROTEUS REAPPEARED AFTER 3RD DRESS.	GRAFTS UNDER TREATMENT HEALING WELL AT 12 WEEKS
13.	" " " 33%	"	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	DRESSED AND GRAFTED AT 18TH, 32ND AND 43RD DAYS	STREP. VIRIDANS	PERSIST	PRIMARY HEALING OF GRAFTS
14.	" " " 28%	"	S.T.E.	C.D.	STAPH. PYOG. COLI	PERSIST PERSIST	DRESSED AND GRAFTED AT 17TH, AND 29TH DAYS			
15.	" " " 15%	"	S.T.E.	C.D.	NONE		DRESSED AND GRAFTED AT 12TH DAY	STAPH. PYOG.	PERSIST	PRIMARY HEALING OF GRAFTS

TABLE A - 6

FRESH TRAUMA

- B U R N S

NO.	TYPE OF BURN AND AREA	SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
16.	DEEP & SUPERFICIAL BURNS 18%	MECHANICAL CLEANSING & WASHING WITH SOAP & WATER	S.T.E.	C.D.	STAPH.PYOG. STREP.PYOG.A	PERSIST DISAPPEAR	DRESSED & GRAFTED 12TH & 22ND DAYS	NONE		HEALING WELL AT 6TH WEEK
17.	CHEMICAL BURNS DEEP & SUP. 7%	"	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	DRESSED & GRAFTED 12TH DAY	NONE		HEALED AT 25TH DAY
18.	CHEMICAL BURNS " " 28%	"	S.T.E. PEN. INTRA MUSCULARLY	C.D.	STAPH.PYOG.	PERSIST	DRESSED & GRAFTED 13TH, 22ND AND 34TH DAYS	NONE		HEALING DELAYED BY PERSISTENT STAPH.PYOGEMPA FOLLOWING ACNE PENICILLIN USED INTRAMUSCULARLY WITH GOOD EFFECT THROUGH STAPH. PERSIST
19.	DEEP & SUPERFICIAL BURNS 18%	"	S.T.E. PEN. INTRA MUSCULARLY	C.D.	STREP.VIRID. STAPH.PYOG.	PERSIST PERSIST	DRESSED & GRAFTED 16TH, 28TH AND 40TH DAYS	NONE		SAFE AS ABOVE - STAPH.PYOG.BECOME PEN.
20.	" " " 5%	"	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	DRESSED & GRAFTED 11TH DAY	NONE		HEALED 4TH WEEK
21.	" " " 8%	"	S.T.E.	C.D.	NONE	PERSIST	DRESSED & GRAFTED 9TH DAY	NONE		HEALED 4TH WEEK
22.	SUPERFICIAL BRUSH BURNS 8%	"	PEN.CR.	C.D.	STAPH.PYOG. COLI	PERSIST PERSIST	NONE. DRESSING REMOVED 14TH DAY	NONE		HEALED 14TH DAY
23.	" " " 5%	"	PEN.CR.	C.D.	STAPH.PYOG.	PERSIST	NONE. " " 10TH DAY	NONE		HEALED 10TH DAY
24.	SUPERFICIAL BURNS 20%	"	S.T.E.	C.D.	NONE		" " " 8TH DAY	NONE		HEALED 8TH DAY
25.	" " " 20%	"	S.T.E.	C.D.	NONE		" " " 8TH DAY	STAPH.PYOG.	PERSIST	HEALED 8TH DAY
26.	" " " 15%	"	S.T.E.	C.D.	NONE		" " " 7TH DAY	STAPH.PYOG.	PERSIST	HEALED 7TH DAY
27.	" " " 25%	"	S.T.E.	C.D.	NONE		" " " 10TH DAY	NONE		HEALED 10TH DAY
28.	" " " 10%	"	S.T.E.	C.D.	NONE		" " " 7TH DAY	NONE		HEALED 7TH DAY
29.	" " " 25%	"	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	" " " 8TH DAY	NONE		HEALED 8TH DAY
30.	" " " 28%	"	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	" " " 9TH DAY	NONE		HEALED 9TH DAY
31.	" " " 20%	"	S.T.E.	C.D.	STAPH.PYOG. COLI	PERSIST PERSIST	" " " 11TH DAY	NONE		HEALED AT 13 DAYS
32.	" " " 25%	"	S.T.E.	C.D.	NONE		DRESSED 10TH DAY REMOVED 17TH DAY	STAPH.PYOG.	PERSIST	HEALED AT 20 DAYS
33.	" " " 20%	"	S.T.E.	C.D.	STAPH.PYOG. PYOCYANEUS	PERSIST PERSIST	NONE. REMOVED 10TH DAY	NONE		HEALED AT 12 DAYS
34.	" " " 18%	"	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	" " " 9TH DAY	STAPH.PYOG.	PERSIST	HEALED AT 10 DAYS
35.	" " " 15%	"	S.T.E.	C.D.	STAPH.PYOG. STREP.PYOG.A	PERSIST DISAPPEAR	DRESSED 14TH DAY REMOVED 20TH DAY	NONE		HEALED AT 21 DAYS
36.	" " " 8%	"	S.T.E.	C.D.	NONE		NONE. REMOVED 7TH DAY	STAPH.PYOG.	PERSIST	HEALED AT 8 DAYS
37.	" " " 15%	"	S.T.E.	C.D.	NONE		NONE. REMOVED 6TH DAY	STAPH.PYOG.	PERSIST	HEALED AT 7 DAYS
38.	" " " 20%	"	S.T.E.	C.D.	STAPH.PYOG. PROTEUS	PERSIST PERSIST	" " " 11TH DAY	STAPH.PYOG.	PERSIST	HEALED AT 14 DAYS
39.	" " " 12%	"	S.T.E.	C.D.	STREP.PYOG.A	DISAPPEAR	" " " 8TH DAY	STAPH.PYOG.	PERSIST	HEALED AT 9 DAYS
40.	" " " 14%	"	S.T.E.	C.D.	NONE		" " " 10TH DAY	COLI	ONE CUL- TURE ONLY	HEALED AT 12 DAYS

TABLE A - 6

FRESH TRAUMAB U R N S

NO.	TYPE OF BURN & AREA	SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
41.	SUPERFICIAL BURNS 25%	MECHANICAL CLEANSING & WASHING WITH SOAP & WATER	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	REMOVED AND DRESSED 1 AM 12TH DAY	NONE		HEALED AT 21 DAYS
42.	" " 30%	"	S.T.E.	C.D.	COLI	PERSIST	REMOVED AND DRESSED 1 LEG 12TH DAY REMOVED 22ND DAY	STAPH. PYOG.	PERSIST	HEALED AT 28 DAYS
43.	" " 8%	"	S.T.E.	C.D.	NONE		NONE. REMOVED 7TH DAY	STAPH. PYOG.	PERSIST	HEALED AT 8 DAYS
44.	" " 35%	"	S.T.E.	C.D.	STREP. PYOG.	DISAPPEAR	DRESSED PARTIALLY 12TH DAY	STAPH. "	PERSIST	HEALED AT 20 DAYS
45.	" " 12%	"	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	REMOVED 6TH DAY	NONE		HEALED AT 7 DAYS

TABLE A - 7

FRESH TRAUMAMISSILE WOUNDS OF SOFT PARTS

NO.	DIAGNOSIS	INITIAL SURGERY	BACTERIO- STATIC	DRESS- ING	INITIAL PATHOGENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
1.	SHRAPNEL WOUNDS BUTTOCKS	WOUND EXCISION PACK	S.T.E.	C.D.	STAPH. PYOG. PROTEUS	PERSIST PERSIST	SEC. SUTURE & RE-DRESSING 21ST DAY DRESSING FORT-NIGHTLY	NONE		DELAY IN HEALING 10 WEEKS
2.	SHRAPNEL WOUNDS BUTTOCKS	" " "	S.T.E.	C.D.	PROTEUS	PERSIST	SEC. SUTURE & RE-DRESSING 21ST DAY DRESSING FORT-NIGHTLY	STAPH.	PERSIST	DELAY IN HEALING 12 WEEKS
3.	SHRAPNEL WOUND BUTTOCKS & LEG	" " "	S.T.E.	C.D.	STAPH. PYOG. PROTEUS	PERSIST PERSIST	SEC. SUTURE & RE-DRESSING 21ST DAY DRESSING FORT-NIGHTLY	NONE		DELAY IN HEALING 10 WEEKS
4.	SHRAPNEL WOUND RT. SHOULDER	" " "	S.T.E.	C.D.	PROTEUS	DISAPPEAR	D.P. SUTURE 14TH DAY	STAPH. PYOG.	PERSIST	SOME DELAY IN HEALING 6 WEEKS
5.	SHRAPNEL WOUND NECK & FACE	" " "	S.T.E.	C.D.	STAPH. PYOG. PROTEUS	PERSIST DISAPPEAR	D.P. SUTURE 7TH DAY	NONE		WOUND HEALED AT END OF 2 WEEKS
6.	GUNSHOT WOUND THIGH THROUGH AND THROUGH	" " "	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	D.P. SUTURE EXIT WOUND 6TH DAY	NONE		HEALED AT 2 WEEKS
7.	REVOLVER WOUND ARM THROUGH AND THROUGH	" " "	S.T.E.	C.D.	NONE		D.P. SUTURE EXIT WOUND 4TH DAY	STAPH. PYOG.	PERSIST	HEALED AT 2 WEEKS
8.	GUNSHOT WOUND CALF THROUGH	" " "	S.T.E.	C.D.	NONE		D.P. SUTURE 6TH DAY	STAPH. PYOG.	PERSIST	HEALED AT 3 WEEKS

TABLE B - 1

PRE-EXISTING INFECTIONS - ACUTE SPREADING WITH OR WITHOUT BACTERAEMIA

NO.	DIAGNOSIS	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	CLINICAL RESULT
1.	INFECTED SARCOMA FOOT LOCAL CELLULITIS	OPEN AMP. SITE OF ELECTION. PACK	S.T.E.	P.C.D.	STREP. PYOG. A STAPH. PYOG.	DISAPPEAR LOCALLY PERSIST	REVISION & SEC. SUTURE 23RD DAY	NONE	HEALED AT 6 WEEKS. FUNCTION WITH PRO- THESIS AT 4 MONTHS. WELL AT 2 YEARS
2.	GANGRENOUS INFECTION FOOT & LEG FROM SUPPURATION OF CHARCOT ANKLE JOINT. EXTENSIVE GANGRENE & CELLULITIS COMATOSE	OPEN AMP. LOWER 1/3 LEG. 4 HOURS AFTER ADMISSION	S.T.E. SULFA- THIAZOLE INTRAVENOUSLY	P.C.D.	STREP. PYOG. A LOCALLY & BAC- TERAEMIA STAPH. PYOG. PROTEUS	DISAPPEAR LOCALLY BLOOD AT 48 HOURS PERSIST PERSIST	OPEN RE-AMP. AT SITE OF ELECTION 16TH DAY. REVISION AND SEC. SUTURE AT 28TH DAY	NONE	HEALED AT 6 WEEKS. AWAITING PROTHE- SIS. FIBULAR STUMP REMOVED AT 3 MONTHS WITH PRIMARY HEALING
3.	GANGRENOUS INFECTION OF FOOT FOLLOWING 12 WEEKS INTERFERENCE WITH CIRCULATION	OPEN AMP. SITE OF ELECTION	S.T.E. SULFADIA- ZINE ORALLY	P.C.D.	STREP. PYOG. A STAPH. PYOG.	DISAPPEAR LOCALLY PERSIST	REVISION & SEC. SUTURE 23RD DAY	NONE	HEALED AT 6 WEEKS FUNCTION WITH PROTHESIS AT 4 MONTHS
4.	ARTERIOCLEROTIC GANGRENE WITH INVASIVE INFECTION FOOT & ANKLE	OPEN AMP. SITE OF ELECTION	S.T.E.	P.C.D.	STREP. PYOG. A STAPH. PYOG.	DISAPPEAR PERSIST	REVISION & SEC. SUTURE 23RD DAY	NONE	HEALED AT 6 WEEKS FUNCTION WITH PROTHESIS AT 4 MONTHS
5.	ARTERIOCLEROTIC GANGRENE WITH EXTENSIVE INVASIVE INFECTION FOOT AND ANKLE	OPEN AMP. SUPRA-CONDYLAR FEMUR	S.T.E. SULFADIAZINE ORALLY	P.C.D.	STREP. PYOG. A STAPH. PYOG.	DISAPPEAR PERSIST	REVISION & SEC. SUTURE 24TH DAY	NONE	HEALED AT 6 WEEKS FUNCTION WITH PROTHESIS AT 5 MONTHS
6.	ARTERIOCLEROTIC GANGRENE WITH INVASIVE INFECTION OF FOOT	OPEN AMP. SITE OF ELECTION	S.T.E.	P.C.D.	STREP. PYOG. C PROTEUS	DISAPPEAR PERSIST	REVISION & SEC. SUTURE 19TH DAY	NONE	HEALED AT 4 WEEKS - FUNCTION WITH PROTHESIS AT 3 MONTHS
7.	9 DAY OLD AC. INF. SUPERFICIAL BURN LEG, FEMORAL ADENITIS	WASHING WITH SOAP AND WATER	S.T.E.	C.D.	STREP. PYOG. A STAPH. PYOG.	DISAPPEAR PERSIST	NONE	NONE	HEALED AT 10 DAYS
8.	5 DAY OLD AC. INF. SUPERFICIAL BURN FACE AND ARM WITH LYMPHANGI- TIS AND ADENITIS	"	S.T.E.	C.D.	STREP. PYOG. A STAPH. PYOG.	DISAPPEAR PERSIST	NONE. DRESSING REMOVED AT 10 DAYS	NONE	HEALED AT 12 DAYS
9.	6 DAY OLD AC. INF. SUPERFICIAL BURN MASTOID FOREARM. LYMPHADENITIS	"	S.T.E.	C.D.	STREP. PYOG. A STAPH. PYOG.	DISAPPEAR PERSIST	NONE. DRESSING REMOVED AT 8 DAYS	NONE	HEALED AT 10 DAYS
10.	10 DAY OLD AC. INF. SUPERFICIAL BURN ANKLE AND FOOT. FEMORAL ADENITIS	"	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	NONE. DRESSING REMOVED AT 9 DAYS	NONE	HEALED AT 10 DAYS
11.	5 DAY OLD AC. INF. SUPERFICIAL BURN FOREARM. LYMPHADENITIS	"	S.T.E.	C.D.	STREP. PYOG. A	DISAPPEAR	NONE. DRESSING REMOVED AT 7 DAYS	STAPH. PYOG.	HEALED AT 6 DAYS
12.	AC. INF. 8 DAY OLD NEGLECTED BURN SCALD AND FACE	"	S.T.E.	C.D.	STREP. PYOG. A STAPH. PYOG.	DISAPPEAR PERSIST	NONE. DRESSING REMOVED AT 8 DAYS	NONE	DRESSING REMOVED AT 5 DAYS
13.	ACUTE OSTEOCELITIS, TIBIA	DRAINAGE PACK	S.T.E.	P.C.D.	STAPH. PYOG. LOCALLY AND BACTERAEMIA	DISAPPEAR FROM BLOOD 3RD DAY PERSIST	AT 3 WKS. DRESSED AT 6 WKS. DRESSED WITH SEC. SKIN GRAFT PERSIST	PROTEUS PERSIST	HEALED AFTER 4 MONTHS (CHILD)
14.	SPREAD. CELLULITIS WRIST RIGHT FOREARM AND ELBOW	INCISION PACK	PEN. INTRA- VEN. LOCALLY S.T.E.	P.C.D.	STREP. PYOG. A	DISAPPEAR	NONE. DRESSED AT 12 DAYS 2ND DRESSING APPLIED	STAPH. PYOG.	HEALED AT 3 WEEKS

TABLE B - 1
PRE-EXISTING INFECTIONS - ACUTE SPREADING WITH OR WITHOUT BACTERAEMIA

NO.	DIAGNOSIS	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SUBSEQUENT SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULT
15.	INF. SMALL WOUND ARM WITH LYMPHANGITIS	NONE PACK	S.T.E.	C.D.	STREP. PYOG. A	DISAPPEAR	NONE. DRESSING REMOVED AT 9 DAYS	NONE		HEALED AT 2 WEEKS
16.	SPREAD CELLULITIS LEG FROM LACERATION OF SKIN	NONE	S.T.E. SULFATHIA- ZOLE ORALLY	C.D.	STREP. PYOG. A	DISAPPEAR	NONE. DRESSING REMOVED AT 10 DAYS	NONE		HEALED AT 3 WEEKS
17.	SPREADING CELLULITIS FOREHEAD FROM LACERATION	NONE	S.T.E.	C.D.	STREP. PYOG. A	DISAPPEAR	NONE. DRESSING REMOVED AT 9 DAYS	NONE		HEALED AT 10 DAYS
18.	AC. OSTEOMYELITIS TIBIA	DRAINAGE. PACK	S.T.E. PEN. INTRA- VENOUS & IN- TRAVEN.	P.C.D.	STAPH. PYOG. LOCALLY AND BACTERAEMIA	" FROM BLOOD 3RD DAY PERSIST LOCALLY	DRESSED AT 3 WEEKS & AT 6 WKS WITH SEC. SUTURE AND SKIN GRAFT	PROTEUS	PERSIST	HEALED AT 6 MONTHS AFTER SEC. SURGERY (CHILD)
19.	AC. OSTEOMYELITIS IMPERVIS	DRAINAGE PACK	S.T.E. SULFATHIA- ZOLE INTRA- VENOUS & ORALLY	P.C.D.	STAPH. PYOG. LOCALLY AND BACTERAEMIA	DISAPPEAR FROM BLOOD 4TH DAY PERSIST LOCALLY	DRESSED AT 4 WKS & AT 10 WKS WITH SEC. SUTURE	STREP. PYOG. A	DISAPPEAR	CHRONIC SINUS PERSISTED AT 3 MONTHS (CHILD)
20.	AC. OSTEOMYELITIS RADIUS	DRAINAGE PACK	S.T.E. PEN. INTRA- VENOUS & ORALLY	P.C.D.	STAPH. PYOG. LOCALLY AND BACTERAEMIA	DISAPPEAR FROM BLOOD 3RD DAY PERSIST LOCALLY	DRESSED AT 4 WKS WITH SEC. SUTURE	NONE		HEALED AT 2 MONTHS (CHILD)
21.	AC. INF. SEVERE LACERATION AVULSION INJURY, ARM	MIN. AND EXCISION DEBRIDEMENT	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	D.P. GRAFT 21ST DAY	PYOCYANEUS	PERSIST	HEALED AFTER 5 WEEKS
22.	AC. INF. LACERATION HAND WITH ABSCCESS AND LYMPHANGITIS	INCISION PACK	B.I.P.P.	C.D.	STAPH. PYOG.	PERSIST	PACK REMOVED AT 14 DAYS C.D.	NONE		HEALED; DRESSING AFTER 21 DAYS
23.	AC. INF. 12 DAYS OLD NEGLECTED BURN ANKLE	NONE	CONTROL BASE	C.D.	STAPH. PYOG.	PERSIST	DRESSING WEEKLY FOR 4 WEEKS	STREP. PYOG. A	DIS- APPEAR	HEALING DELAYED FOR 6 WEEKS
24.	AC. FLEXOR TENOSINOVITIS, MIDDLE FINGER	INCISION PACK	PEN. CR.	P.C.D.	STAPH. PYOG.	PERSIST	DRESSED AT 18 DAYS AND PACK REMOVED	NONE		SLOW HEALING. STILL UNHEALED AFTER 6 WEEKS
25.	AC. INF. HUMAN BITE OF HAND ABSCCESS	INCISION PACK	PEN. CR. INTRA- VENOUS N.A.B.	P.C.D.	BOR. VINCENTI & FUSIFORMES	" UNTIL NAB GIVEN SINUSITIS DECREASED	DRESSED EVERY 4 DAYS FINGER AND AT 12 DAYS SEC. SUTURE AT 26 DAYS	NONE		HEALING DELAYED FOR 9 WKS
26.	AC. INF. STAB WND & BUTTOCK	EXCISION PACK	S.T.E.	C.D.	STAPH. PYOG.	" GRADUALLY DISAPPEARED 4TH DAY BACTERAEMIA DISAPPEARED 3 DAYS	D.P. SUTURE 8TH DAY	NONE		HEALED AT 3 WEEKS
27.	AC. GANG. INF. 5 DAY OLD. AVULSION INJURY OF UPPER ARM INVOLVING CIRCUMF. EXT. SKIN WHOLE ARM. HAD PRIMARY SUTURE IN COUNTRY	MAX. EXCISION	S.T.E. SUL- FATHIAZOLE INTRA- VENOUS & ORALLY	P.C.D. SPICA	STREP. PYOG. A & BACTERAEMIA STREP. PYOG. A LOCALLY		D.P. SPLIT SKIN GRAFT AT 14 DAYS	NONE		HEALED AT 4 WEEKS WORKING AT 9
28.	AC. INF. OF BURN PRE-EXISTING STAPH. PYOCYAN	INCISION ABSCESS & FURUNCLES	S.T.E. PEN. INTRA- VENOUS	C.D.	STAPH. PYOG. PYOCYANEUS	PERSIST	SEC. SKIN GRAFTING 36 DAYS	STAPH. PYOG. BECAME PEN. RESISTANT	PERSIST	HEALING DELAYED (10 WEEKS)
29.	AC. INF. STAB WND FOREARM LYMPHANGITIS	INCISION PACK	S.T.E. SUL- FATHIAZOLE ORALLY	C.D.	STREP. PYOG. A	DISAPPEARED 3 DAYS	D.P. SUTURE AT 6 DAYS	NONE		HEALED AT 2 WEEKS
30.	AC. INF. BLISTER LEFT HEEL	REMOVAL BLISTER TOP	S.T.E.	C.D.	STAPH. PYOG.	DISAPPEARED	NONE. DRESSING REMOV. 8TH DAY			HEALED AT 2 WEEKS
31.	SPREAD. CELLULITIS WND OF ANKLE	NONE PACK	S.T.E.	P.C.D.	STREP. PYOG. A	DISAPPEARED	D.P. SKIN GRAFT AT 12 DAYS	STAPH. PYOG.	PERSIST	HEALED AT 3 WEEKS
32.	SPREAD. CELLULITIS WND OF ARM	NONE PACK	S.T.E. SUL- FATHIAZOLE ORALLY	C.D.	STREP. PYOG. A	DISAPPEARED	DRESSING REMOVED AT 9 DAYS	NONE		HEALED AT 12 DAYS

32.	SPREAD-CELLULITIS WIND OF ARM	NONE	PACK	S.T.E.-SUL- FATHIAZOLE ORALLY	C.D.	STREP.PYOG.A.	DISAPPEARED	DRESSING REMOVED AT 9 DAYS	NONE	HEALED AT 12 DAYS
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TABLE B - 2 PRE-EXISTING INFECTIONS - ACUTE INFECTIONS LOCALIZED AND LOCALIZING

NO.	DIAGNOSIS	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SECONDARY SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
1.	AC-SOFT TISSUE ABSCESS OF THE ARM	INCISION PACK	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	D.P. SUTURE 16 DAYS	NONE		HEALED AFTER 5 WEEKS
2.	AC-CHRONIC LEG ULCER (A) ABSCESS IN UPPER THIGH (B) ABSCESS IN LOWER LEG (A) & (B) METASTATIC	A) INCISION PACK B) "	A) S.T.E. B) PEN.CR.	P.C.D. P.C.D.	A) STREP.HAEMO. NOT A, B, OR C B) STREP.HAEMO. NOT A, B, OR C	DIS- APPEARED	THIGH D.P. SUTURE AT 14 DAYS D.P. GRAFT AND SUTURE AT 14 DAYS. LEG	NONE STAPH.PYOG.	PERSIST	ALL AREAS HEALED AT 5 WKS
3.	AC. PULVAR ABSCESS	INCISION PACK	B.I.P.P.	C.D.	STREP.PYOG. A	DISAPPEARED	DRESSING ON 10TH DAY	STAPH.PYOG.	PERSIST	HEALED AT 17 DAYS
4.	CARBUNCLE - BACK	EXCISION PACK	PEN.CR.	C.D.	STAPH.PYOG.	PERSIST	DRESSED WEEKLY SEC-GRAFTING AT 18 DAYS	NONE		HEALED AT 4 WEEKS
5.	CARBUNCLE - BUTTOCK	EXCISION PACK	PEN.CR.	C.D.	STAPH.PYOG.	PERSIST	DRESSED EVERY 5 DAYS	NONE		HEALED AT 4 WEEKS
6.	CARBUNCLE - NECK	EXCISION PACK	PEN.CR.	C.D.	STAPH.PYOG.	PERSIST	DRESSED & SEC. SUTURE 2 WKS	NONE		HEALED AT 4 WEEKS
7.	SUBCUTANEOUS PALMAR ABSCESS	INCISION PACK	PEN.CR.	C.D.	STAPH.PYOG.	PERSIST	DRESSED AT 1 WEEK REMOVED AT 12 DAYS	NONE		HEALED AT 4 WEEKS
8.	AC-SUBCUTANEOUS PALMAR ABSCESS	INCISION PACK	PEN.CR.	C.D.	STREP.PYOG.A	DISAPPEARED	DRESSED AT 1 WEEK " AT 12 DAYS	NONE		HEALED AT 3 WEEKS
9.	AC-INF. LACERATION HAND ABSCESS	INCISION PACK	S.T.E.	P.C.D.	STAPH.PYOG. PYOCYANUS	PERSIST	DRESSED AT 2 WEEKS " AT 3 WKS	NONE		HEALED AT 4 WEEKS
10.	CARBUNCLE NECK	EXCISION PACK	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	DRESSED EVERY 5 DAYS	NONE		HEALED AT 4 WEEKS
11.	CARBUNCLE NECK	EXCISION PACK	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	EXCISION & SUTURE AT 2 WKS	NONE		HEALED AT 4 WEEKS
12.	INF. LACERATION HAND, ABSCESS	INCISION PACK	S.T.E.	P.C.D.	STAPH.PYOG. PYOCYANUS	PERSIST	DRESSED AT 14 DAYS REMOVED AT 3 WEEKS	NONE		HEALED AT 4 WEEKS
13.	AC. THENAR ABSCESS	INCISION PACK	S.T.E.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED AT 14 DAYS REMOVED AT 4 WEEKS	NONE		HEALED AT 4 WEEKS
14.	CARBUNCLE NECK	EXCISION PACK	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	DRESSED AT 10 DAYS	NONE		HEALED AT 3 WEEKS
15.	CARBUNCLE BUTTOCK	EXCISION PACK	PEN.CR.	C.D.	STAPH.PYOG.	PERSIST	DRESSED WEEKLY NONE	NONE		HEALED AT 3 WEEKS
16.	CARBUNCLE NECK	EXCISION PACK	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	DRESSED WEEKLY SEC.SUTURE 2 WEEKS	NONE		HEALED AT 4 WEEKS
17.	AC.THENAR ABSCESS	INCISION PACK	S.T.E.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED, SUTURE AT 2 WKS	NONE		HEALED AT 4 WEEKS
18.	AC.THENAR ABSCESS	INCISION PACK	S.T.E.	P.C.D.	STAPH.PYOG. STREP.PYOG.A	PERSIST DISAPPEAR	DRESSED, SUTURE AT 2 WKS	NONE		HEALED AT 5 WEEKS
19.	CARBUNCLE NECK	EXCISION PACK	S.T.E.	C.D.	STAPH.PYOG.	PERSIST	DRESSED EVERY 4 DAYS	NONE		HEALED AT 26 DAYS
20.	CARBUNCLE NECK, NOT BROKEN DOWN	NONE	PEN.INTRA- MUSC.	C.D.	STAPH.PYOG.	PERSIST	NONE	NONE		HEALED AT 10 DAYS
21.	SEVERE INF. FACE ANGULAR VEIN THROMBOSIS	NONE	PEN.INTRA- MUSC.	C.D.	STAPH.PYOG.	PERSIST	NONE	NONE		HEALED AT 14 DAYS
22.	CARBUNCLE BUTTOCK, NOT BROKEN DOWN	NONE	PEN.INTRA- MUSC.	C.D.	STAPH.PYOG.	PERSIST	NONE	NONE		" AT 10 DAYS
23.	CARBUNCLE BUTTOCK, EXCISION PACK	EXCISION PACK	PEN.CR.	C.D.	STAPH.PYOG.	PERSIST	NONE	PROTEUS	PERSIST	HEALED AT 21 DAYS

TABLE B - 2 PRE-EXISTING INFECTIONS - ACUTE INFECTIONS LOCALIZED AND LOCALIZING

NO.	DIAGNOSIS	PRIMARY SURGERY	BACTERIO-STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAME	SECONDARY SURGERY	NEW PATHOGENS	FATE OF SAME	CLINICAL RESULTS
24.	LARGE SUBCUTANEOUS ABSCESS HAND	INCISION PACK	S.T.E.	P.C.D.	STAPH. PYOG. PYOCYANEUS	PERSIST	DRESSED AT 14 DAYS REMOVED AT 3 WEEKS	NONE		HEALED AT 4 WEEKS
25.	THUMB ABSCESS	INCISION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	DRESSED & D.P. SUTURE AT 16 DAYS	NONE		HEALED AT 5 WEEKS
26.	PALMAR ABSCESS	INCISION PACK	PEN. CR.	P.C.D.	STAPH. PYOG.	PERSIST	DRESSED & D.P. SUTURE AT 17 DAYS	NONE		HEALED AT 6 WEEKS
27.	SUPP. TENDONITIS MID-FINGER CELLULITIS, ABSCESS LUMBRICAL SPACE AL	MULTIPLE INCISION PACK	S.T.E.	C.D.	STAPH. PYOG. STREP. PYOG. A	PERSIST DISAPPEAR	DRESSED & D.P. SUTURE AT 15 DAYS	NONE		HEALED AT 7 WEEKS
28.	PALMAR ABSCESS	INCISION PACK	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	DRESSED & D.P. SUTURE AT 2 WKS	NONE		HEALED AT 5 WEEKS
29.	LUMBRICAL SPACE ABSCESS	INCISION PACK	S.T.E.	C.D.	STREP. PYOG. A	DISAPPEAR	DRESSED WEEKLY	STAPH. PYOG.	PERSIST	HEALED AT 4 WEEKS

TABLE B - 3 PRE-EXISTING INFECTIONS - CHRONIC INFECTIONS - PYOGENIC

NO.	DIAGNOSIS	PRIMARY SURGERY	BACTERIO-STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAME	SECONDARY SURGERY	NEW PATHOGENS	FATE OF SAME	CLINICAL RESULTS
1.	CHR. OSTEOMYELITIS HUMERUS	SEQUESTRECTOMY & SAUCERIZATION PACK	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	NONE. DRESSED FORT-NIGHTLY	STREP. PYOG. A	IN ONE CULTURE ONLY	SMALL PERSISTENT SINUS AFTER 4 MONTHS REMOVED HEALED 6 MONTHS
2.	CHR. OSTEOMYELITIS HUMERUS RESISTUAL SEQUESTRUM	SEQUESTRECTOMY & SAUCERIZATION PACK	S.T.E.	C.D.	NONE		DRESSED FORT-NIGHTLY	STAPH. PYOG.	PERSIST	PERSISTENT SINUS AFTER 4 MONTHS REQUIRES SURGERY
3.	CHR. OSTEOMYELITIS TROCHANTER	SEQUESTRECTOMY & SAUCERIZATION PACK	S.T.E.	C.D.	STAPH. PYOG.	PERSIST	DRESSED FORT-NIGHTLY	NONE		PERSISTENT SINUS & SEQUESTRUM AFTER 4 MONTHS
4.	CHR. OSTEOMYELITIS, TIBIA BRODIE ABSCESS	SAUCERIZATION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	DRESSED SEC. SPLIT SKIN GRAFT AT 21ST DAY	NONE		HEALED AFTER 6 WEEKS
5.	CHR. OSTEOMYELITIS, TIBIA BRODIE ABSCESS	SAUCERIZATION PACK	S.D.E.	P.C.D.	STAPH. PYOG.	PERSIST	DRESSINGS AT 3 WEEKS INTERVALS	NONE		HEALED COMPLETELY AT 9 WEEKS
6.	CHR. OSTEOMYELITIS, TIBIA SEQUESTRUM	SAUCERIZATION PACK	S.D.E.	P.C.D.	STAPH. PYOG. STREP. PYOG. A	PERSIST DISAP. AT 3 DAYS	DRESSINGS AT 3 WEEK INTERVALS	PYOCYANEUS	PERSIST	HEALED AT 8 WEEKS (CHILD)
7.	CHR. OSTEOMYELITIS, TIBIA SEQUESTRUM	SAUCERIZATION PACK	PROFLAVINE E.	P.C.D.	STAPH. PYOG.	PERSIST	DRESSINGS AT 3 WEEKS INTERVALS	NONE		HEALED AT 2 MONTHS
8.	A) CHR. OSTEOMYELITIS PELVIS ABSCESS THIGH B) CHR. OSTEOMYELITIS & SEQUESTRUM	INCISION SEQUESTRECTOMY PACK	PEN. CR.	C.D.	STAPH. PYOG.	PERSIST	DRESSED WEEKLY	NONE		HEALED AFTER 5 WEEKS
9.	CHR. OSTEOMY. TIBIA BRODIE ABSCESS DEEP	SAUCERIZATION PACK	S.T.E.	P.C.D.	STAPH. PYOG.	PERSIST	DRESSED FORTNIGHTLY	NONE		PERSISTENT SINUS FURTHER SURGERY, HEALED 10 WKS
							DRESSED MUSCLE GRAFT 2 WKS SPLIT SKIN GRAFT 4 WKS	NONE		HEALED AFTER 8 WEEKS

TABLE B - 3

PRE-EXISTING INFECTIONS

CHRONIC INFECTIONS - PYOGENIC

NO.	DIAGNOSIS	PRIMARY SURGERY	BACTERIO- STATIC	TYPE OF DRESSING	INITIAL PATHOGENS	FATE OF SAFE	SECONDARY SURGERY	NEW PA- THOGENS	FATE OF SAFE	CLINICAL RESULTS
10.	CHR. OSTEOMY. TIBIA BRODIE ABSCESS	SAUCERIZATION PACK	PEN.CR.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED FORTNIGHTLY SEC. SKIN GRAFT 4 WKS	NONE		HEALED AT 12 WEEKS
11.	CHR. OSTEOMY. TIBIA BRODIE ABSCESS	SAUCERIZATION PACK	PEN.CR.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED FORTNIGHTLY SEC.SKIN GRAFT 4 WKS	NONE		HEALED AT 12 WEEKS
12.	CHR. OSTEOMY. HUMERUS WITH SEQUESTRUM	SEQUESTRECTOMY PACK	PEN.CR.	C.D.	STAPH.PYOG.		DRESSED WEEKLY	NONE		HEALED AT 4 WEEKS
13.	CHR. OSTEOMY. TIBIA	SAUCERIZATION PACK	PEN.CR. PEN.SOLN PEN.INTRA- MUSC.	P.C.D.	STAPH.PYOG.	PEN.FAST ORGANISMS	DRESSED SKIN GRAFT AT 1 MONTH	NONE		HEALED AT 2 MONTHS
14.	CHR. OSTEOMY. RADIUS	SAUCERIZATION PACK	PEN.CR. PEN.INTRA- MUSC.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED 1 MONTH SUTURE SEC. SUTURE	NONE		HEALED AT 8 WEEKS
15.	CHR. OSTEOMY. FEMUR SEQUESTRUM	SEQUESTRECTOMY SAUCERIZATION PACK	S.T.E.PEN. INTRAVEN.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED 1 MONTH SEC.SUTURE	NONE		HEALED AT 9 WEEKS
16.	CHR. OSTEOMY. FEMUR	SAUCERIZATION PACK	S.T.E.PEN. INTRAVEN.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED 3 WEEKS SEC.SUTURE	NONE		HEALED AT 8 WEEKS
17.	CHR. OSTEOMY. RADIUS	SAUCERIZATION PACK	S.T.E.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED 3 WKS SEC. SUTURE	NONE		HEALED AT 6 WKS (CHILD)
18.	CHR. LEG ULCER	NONE	S.T.E.	P.C.D.	STAPH.PYOG. STREP.PYOG.A	PERSIST DISAP. 4 DAYS	NONE	NONE		HEALED 10 DAYS ONE DRESSING
19.	CHR. LEG ULCER	EXCISION PACK	S.T.E.	P.C.D.	NONE		D.P. SKIN GRAFT 18TH DAY	STAPH.PYOG.	PERSIST	HEALED AFTER 4 WKS
20.	CHR. TRAUMATIC LEG ULCER EX- POSING TIBIA, SMALL AREA LOCAL OSTEOITIS	EXCISION PACK	CONTROL PEN S.D.E.	P.C.D.	STREP.PYOG.A STAPH.PYOG.	PERSIST PERSIST	D.P. SKIN GRAFT 10 DAYS GRAFT TOTAL LOSS RE-DRESS S.D.E. 1 WK RE-GRAFT WITH S.D.E.	STREP.PYOG.A	PERSIST 1ST GRAFT DISAP. WITH S.D.E. BEFORE 2ND	100% TAKE OF SECOND GRAFT 2 WKS
21.	CHR. LEG ULCER	NONE	PEN.CR.	C.D.	STAPH.PYOG. COLI	PERSIST PERSIST	DRESSED WEEKLY	NONE		HEALED AFTER 5 WKS
22.	CHR. LEG ULCERS, TROPIC	NONE	PEN.CR.	P.C.D.	STAPH.PYOG.	PERSIST	DRESSED WEEKLY	NONE		HEALED AT 4 WKS
23.	CHR. LEG ULCER	NONE	S.T.E.	C.D.	STREP.VIRID.	PERSIST	DRESSED WEEKLY	NONE		HEALED AT 4 WKS
24.	CHR. LEG ULCER	NONE	S.T.E.	P.C.D.	STAPH.PYOG. PROTEUS	PERSIST PERSIST	DRESSED WEEKLY	NONE		HEALED AT 6 WKS
25.	CHR. LEG ULCER	NONE	S.T.E.	C.D.	STAPH.PYOG. STREP.PYOG.A	PERSIST DISAPPEAR	D.P. SKIN GRAFT AFTER 2 WKS REMOVED 4 WKS	NONE		HEALED AT 5 WKS
26.	CHR. LEG ULCER	NONE	S.T.E.	C.D.	STAPH.PYOG. STREP.PYOG.A	PERSIST DISAPPEAR	D.P. SKIN GRAFT AT 2 WKS REMOVED 4 WKS	NONE		HEALED AT 6 WKS
27.	CHR. LEG ULCER	NONE	S.T.E.	C.D.	STAPH.PYOG. STREP.VIRID.	PERSIST DISAPPEAR	D.P. SKIN GRAFT AT 2 WKS REMOVED 4 WKS	NONE		HEALED AT 5 WKS
28.	CHR. OSTEITIS TIBIA TRAUMATIC	SAUCERIZATION PACK	PEN.CR.	P.C.D.	STAPH.PYOG.	PERSIST	D.P. SKIN GRAFT AT 2 WKS DRESSED FORTNIGHTLY	NONE		GRAFTED SITE HEALED AFTER 6 WKS

2. *Acute localized and localizing infections (one control). (29 cases including carbuncles; and abscesses of various regions.)*

Treated surgically as the previous group and with equally successful results. It may be noted that in this group three cases of acute staphylococcal infection were successfully treated by systemic penicillin, surgery not being indicated.

3. *Chronic pyogenic infections (two controls). (29 cases including chronic osteomyelitis and chronic leg ulcers.)*

In all cases surgery was found to be of greater usefulness in achieving results than bacteriostatics of any type. Topical sulfathiazole was found to be useful following each surgical procedure, topical penicillin,⁷ by contrast, was less satisfactory, and this substance was more usefully administered systemically. In a few pyogenic empyemata, not shown in the tables, topical penicillin in solution has been found to be very satisfactory bacteriologically but, as elsewhere, has led to further surgical problems, and drainage is definitely indicated.

N. B. Secondary suture and split-skin grafting were employed as in all other groups.

The following points summarize the authors' convictions. They form the basis for the subsequent discussion:

1. The nature, age and extent of any injury or infection profoundly modify the value of any antibiotic substance.
2. Adequate surgery is more essential in the treatment of trauma than are chemotherapeutic substances.
3. The mere presence of bacteria in a wound is by no means synonymous with infection.
4. Bacteria tend to persist in a healing wound up to the time of complete and final epithelization without clinical signs of infection.
5. Pyogenic streptococci regularly disappear from wounds and preëxisting infections treated with sulfonamides or penicillin. Most other wound pathogens, notably *Staphylococcus pyogenes*, *B. proteus vulgaris*, *Ps. pyocyanea* and *Cl. welchii* persist in the presence of chemotherapy without necessarily producing clinical infection.
6. Bacteria in wounds were a far greater hazard in presulfonamide days than at present, despite our inability to sterilize a wound completely.
7. Penicillin topically applied has not proved as effective an agent as sulfathiazole, probably because of its rapid disappearance, which makes frequent exposure of the wound necessary. Its routine systemic use in a large ward with normal personnel is much more burdensome than the more convenient sulfonamides.
8. It seems inescapable that bacteriostatics help to restrain the contaminated wound from becoming an infected wound. This they must do by prolonging the important "lag-period," restraining during this time free bacterial multiplication, and allowing elaboration of the natural barrier to microbic invasion.

9. All this is facilitated by immobilization and occlusive compression dressings, infrequently changed.

10. Hypersensitivity reaction from topically applied sulfonamides is a highly controversial issue. We, however, have seen such little evidence of it with infrequent dressings that we consider the risk entirely unimportant.

11. We have no convincing evidence that such bacteriostatics as we have used significantly influence *Ps. pyocyanea* or *B. proteus vulgaris* in a wound. These remain one of our outstanding problems.

12. Either to condemn bacteriostatics unreservedly or to endorse them as "miracle drugs" is to evince completely uncritical judgment. The truth, as usual, lies somewhere between. In our opinion, as far as trauma is concerned, the most efficient of them is, at best, only the junior partner of adequate surgery.

13. In chronic surgical infections, surgery is paramount. In acute localized infections, surgery and chemotherapy are interdependent. In acute spreading infections, chemotherapy is the immediate necessity.

The conclusions previously stated will now be discussed in some detail.

1—*The nature, age and extent of any injury profoundly modify the use of any antibiotic substance.*

These studies confirm our previous findings in showing a great difference between the effectiveness of such antibiotic substances as sulfonamides, employed prophylactically in a case of fresh trauma, and their therapeutic value in an extensive preëxisting infection. It is quite useless to discuss the value of the topical use of any antibiotic substance in the presence of a severe spreading acute infection, with or without bacteremia. In the latter case it is obvious that only systemic attack, by whatever route possible and with whatever bacteriostatic agent is most specific, is the method of achieving clinical success. Case 2, Table B-1, previously mentioned, is an excellent illustration of this. By contrast, a superficial infection with *Streptococcus pyogenes* is apparently easily controllable with topical application of at least any of the sulfonamides (or penicillin). Recent injuries coming under observation during the "lag-period" lend themselves well to topical therapy. In older lesions, particularly those with extensive tissue devitalization, the influence of bacteriostatics is not so marked. Many reports in the literature have failed to give these facts due consideration.

2—*Adequate surgery is more essential in the treatment of trauma than are chemotherapeutic substances.*

This statement is fundamental, and must also include an appreciation of the value of the infrequent change of compressive immobilizing dressings. It has been demonstrated to us beyond doubt that clinical failure in any of our cases can be traced to inadequate surgery of some sort, including inadequate drainage. An example of this is shown by the fact that the only two existing infected cases which failed to show proper response were proved to have inadequate incision for drainage. It may be pointed out that tension from

tight suturing is a prime factor in promoting local infection, such as stitch abscesses. It seems to us superfluous to have to restate this matter, though Churchill,² in his report from North Africa and Italy, found it expedient to do so. Bacteriostatics have a useful supporting rôle, insofar as they extend the "lag-period" and make many surgical procedures far safer.

3—The mere presence of bacteria in a wound is by no means synonymous with infection.

It is certain that no military or civilian accident ever presents a sterile wound. All of them are contaminated. The majority of them remain contaminated up to the time of healing, yet, under appropriate treatment, few ever give clinical signs of infection. Infection has an incubation period and must, therefore, be considered related to bacterial multiplication. Bacteriostatics, especially if applied early, should obviously minimize this risk. Again, infection is related to the spread of bacteria from the point of entry. This spread, determined in a considerable measure by the species of microbe, will be along existing channels—lymphatics, fascial planes, tissue spaces—but always in the tissue fluids. Any massaging influence will facilitate this spread, and immobilization with compression dressings will minimize it. The two factors of bacteriostasis and immobilization are intimately concerned with preventing a contaminated wound from becoming an infected one (see tables).

4—Bacteria often persist in the healing wound up to the time of complete and final epithelization without clinical signs of infection.

Explanation of this is found in the main in comments in the previous paragraph. It is not, in our opinion, the exception but rather the rule, as our tables clearly indicate.

5—Pyogenic streptococci regularly disappear from wounds and preëxisting infections treated with sulfonamides. Most other wound pathogens, notably Staphylococcus pyogenes, B. proteus vulgaris, Ps. pyocyanea, Cl. welchii, persist in the presence of chemotherapy without necessarily producing clinical infection.

Success in the elimination of pyogenic streptococci in our cases, with topical application alone, is, we feel, the most significant factor in the prevention of infection in fresh trauma. Moreover, the regularly successful elimination of many extensive and even invasive local streptococcal infections by topical sulfonamides alone has conclusively proved the value of the topical chemotherapy for these organisms. Much can be said in elaboration of this statement and will be dealt with in a later report. Excellent examples of the clearing of infection from wounds can be found in the tables as, for example, the infected burns. It is probable that elimination of the streptococcus, which was the great infection menace of World War I, has also decreased the opportunities for other pathogens. It seems inescapable that some restraint in their growth occurs, for in only a very few of our cases was there prolonged delay in wound healing. In most cases, healing was entirely uninterrupted in spite of persistence of bacteria. *Staphylococcus pyogenes*, and *Cl. welchii*

respond to chemotherapy under appropriately favorable conditions. It is generally maintained, however, that *B. proteus vulgaris* and *Ps. pyocyanea* are not influenced by present-day bacteriostatics.* It is probable, therefore, that such success as we have had in this admittedly small series, is due to the surgical and dressing technic and not to the bacteriostatic.

6—*Bacteria in wounds were a far greater hazard in presulfonamide days than at present despite our inability to sterilize a wound completely.*

This statement has been covered in the foregoing paragraph and requires no further elucidation.

7—*Penicillin topically applied has not proved as effective an agent as sulfathiazole, probably because of its rapid disappearance which makes frequent exposure of the wound necessary. Its systemic use in a large ward, with normal personnel, is much more burdensome than the more convenient sulfonamides.*

We have had over a year's experience with topical application of this substance, mainly in various cream bases. It is our frank opinion that, in the main, their topical use has been disappointing. We have found it roughly equivalent to sulfathiazole in its effect on streptococcus in wounds, but equally ineffective where the staphylococcus was concerned. Penicillin is either destroyed or eliminated from the local application, even when large amounts are used, in a matter of hours rather than days. The cause of this elimination is rapid absorption on the one hand, aided, on occasion, by destruction by penicillinase-producing organisms. The natural deduction from this is that, practically speaking, its employment is restricted only to very superficial and localized lesions in which there is no danger whatever of contamination by coliform organisms. Finally, this disability, which is not true of the sulfonamides, would make penicillin impractical as a general bacteriostatic agent in the cream form.

8—*It seems inescapable that bacteriostatics help to restrain the contaminated wound from becoming an infected wound. This they must do by prolonging the important "lag-period," restraining during this time free bacterial multiplication and allowing elaboration of the natural barrier to microbic invasion.*

This statement, again, requires little further elaboration.

9—*All this is facilitated by immobilization wherever possible and occlusion by compression dressings.*

The importance of establishing the practice of immobilization with large, bulky, and other occlusive compression dressings, cannot be overemphasized. These dressings require no change until some specific surgical intervention is planned, or until healing has occurred. Their time of change has depended upon the above factors only, whether that time be a matter of days or weeks, as in compound fractures. We would reiterate the point already made, in previous reports, that frequent change of dressings not only allows for con-

* This was written prior to our experience with Streptomycin. Data in this field being collected now for future publication.

tamination by pathogens, but always carries with it the risk of damage to healing tissues, with bleeding and further risk of infection. We believe that the practice described is already well established.

10—Hypersensitivity to sulfonamides.

This highly controversial issue has been constantly under our scrutiny since the outset of this work. The fact that in only a single instance in our series of some 250 cases has there been a generalized rash, and in only two cases a local irritation, has led us to consider this matter as unimportant when the practice of infrequent dressing is carried out. It is perhaps noteworthy that two of these three cases lost their hypersensitivity within a year. Investigations prior to this project by one of the authors (F. D. A.⁸) showed no consistently important blood levels, even when large quantities of sulfonamides were used topically. The systemic use of the drug has been confined by us to only those very few cases where widespread extensive infection, with or without bacteriemia had preëxisted. We are not, here, concerned with hypersensitivity as a result of systemic therapy. Confining our comments, therefore, to topical therapy, we can find no objection whatever on this score, provided the practice of infrequent dressings is followed. It has been known to us, as well as to others,^{1, 4, 5} that the abuse of therapy by too frequent applications may lead to a considerable percentage of hypersensitivity.

11—We have no convincing evidence that such bacteriostatics as we have used significantly influence Ps. pyocyanea or B. proteus vulgaris in a wound.

These remain among our outstanding problems.

12—Either to condemn bacteriostatics unreservedly or to endorse them as "miracle drugs" is to evince completely uncritical judgment. The truth, as usual, lies somewhere between. In our opinion, as far as trauma is concerned, the most efficient of them is, at best, only the junior partner of adequate surgery.

This statement requires no elaboration.

13—In chronic surgical infections surgery is paramount. In acute localized infections, surgery and chemotherapy are interdependent. In acute spreading infections chemotherapy is the immediate necessity.

This statement requires no elaboration.

The mechanisms underlying wound infection and wound healing clearly involve many factors, among them the state of nutrition of the patient and the general physiologic condition of the tissues. Evaluation of the rôle of chemotherapy, and, indeed, of surgery, must take into account these other factors. We have tended of late to look upon traumatic wounds as being, in a fashion, contaminated tissue cultures, with the rest of the body serving essentially to nourish and incubate both host cells and bacteria. The object of all the influences brought to bear in the name of therapy is to minimize the possible adverse effects of bacterial multiplication without depressing, indeed, if possible with stimulating, the reparative process of the host's tissue

cells. It is the interplay of the factors involved in this process which we propose to examine at greater length in a subsequent publication.

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PAIN IN MEN WOUNDED IN BATTLE

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THERE IS A COMMON BELIEF that wounds are inevitably associated with pain, and, further, that the more extensive the wound the worse the pain. Observation of freshly wounded men in the Combat Zone showed this generalization to be misleading. If one may speak of such a subjective experience as pain in exact terms, the generalization can be said to hold in only about one-quarter of severely wounded men; it fails in the remaining three-quarters. There are practical reasons for examining this problem, for a clear appreciation of its nature will lead to improved treatment of the distress of the wounded.

The widespread tendency to serious error in the employment of one of the most useful drugs in medicine, morphine, also suggested that the treatment of pain in wounded men needed to be reviewed. An opportunity to do this was made possible during the prolonged action on the Venafrò and Cassino Fronts and later at the Anzio Beachhead and in France.

MATERIAL

The factual material which serves as the basis for the observations made here is largely presented in Table I. Consecutive cases were observed, insofar as this was possible. There was no selection of patients other than (a) they had one of five kinds of severe wounds chosen as representative; extensive peripheral soft-tissue injury, compound fracture of a long bone, a penetrated head, a penetrated chest, or a penetrated abdomen; (b) they were clear mentally; and (c) they were not in shock at the time of questioning. (If shock was present on arrival, as in a few cases, questioning was delayed until the shock had been relieved.) Men wounded in battle usually have multiple wounds. The categories listed refer to the chief wound.

INCIDENCE OF PAIN

Three factors are of major importance in the suffering of badly wounded men: pain; mental distress; and thirst. Therapy has been almost entirely directed to pain, and this usually limited to the administration of morphine in large dosage. In a consideration of the pain of seriously wounded men it is advisable to distinguish between those in good general condition and those in shock. Pain and mental distress are encountered in the former group; but in well-developed traumatic shock such suffering as can be detected is commonly not from wound pain or anxiety, but is chiefly from thirst. This will be discussed briefly a little later.

To get at the incidence of pain in the several groups of patients, questions asked shortly after entry in a Forward Hospital were phrased in this way: "As you lie there are you having any pain?" (Care was taken to be certain

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that the patient understood the question.) If the answer was "No," that part of the questioning was dropped. If the answer was "Yes," further inquiry was made: "Is it slight pain, or moderate pain, or bad pain?" There was usually little hesitation about differentiating here. The patients who said they were having pain of any degree were asked further if the pain was great enough that they wanted something to relieve it. (It became apparent early that morphine was an unfortunate word to use in this questioning, and it was avoided, since some were alarmed by the implication that they were "bad enough" to need this agent.) The findings are recorded in Table I.

TABLE I
215 PATIENTS WITH MAJOR WOUNDS

(Standard Errors of the Mean are Shown)

Type of Wound	Compound Fractures of Long Bones	Extensive Soft-tissue Wounds	Penetrating Wounds of Thorax	Penetrating Wounds of Abdomen	Penetrating Wounds of Cerebrum
Number of pts.	50	50	50	50	15
Pt's age (yrs.)	24.8 ± 0.9	24.5 ± 1.1	24.5 ± 0.8	22.7 ± 0.6	25.1 ± 1.4
Time since wounding (hrs.)	12.5 ± 1.3	11.3 ± 1.4	9.8 ± 1.0	7.2 ± 0.7	7.9 ± 1.4
Avg. total dose of morphine (mg.)	1 pt.: none* 49 pts. avgd. 27.0 ± 1.5	11 pts.: none* 39 pts. avgd. 27.0 ± 2.7	11 pts.: none* 39 pts. avgd. 25.0 ± 1.8	5 pts.: none* 45 pts. avgd. 29.0 ± 2.2	8 pts.: none* 7 pts. avgd. 19.8 ± 4.2
Avg. latest dose of morphine (mg.) (spread as above)	22.6	19.5	21.2	25.0	19.8
Time since latest morphine (hrs.)	7.0 ± 0.8	7.2 ± 0.6	6.5 ± 0.6	4.8 ± 0.7	6.2 ± 1.5
Pain (degree).	19 none	19 none	15 none	7 none	9 none
(Number of pts. in each group)	12 slight 7 moderate 12 bad	15 slight 8 moderate 8 bad	18 slight 11 moderate 6 bad	5 slight 14 moderate 24 bad	5 slight 0 moderate 1 bad
Further pain relief therapy wanted (pts.)	11 yes 39 no	9 yes 41 no	10 yes 40 no	27 yes 23 no	1 yes 14 no
Remarks on pts. with "bad pain" (morphine in mg.)	12 pts. avg. latest dose morphine 24.8, 5.7 hrs. ago; avg. total dose 33.6	7 pts. (1 no morphine*) avg. latest dose morphine 22.8, 9 hrs. ago; avg. total dose 33.0	5 pts. (1 no morphine*) avg. latest dose morphine 19.0, 6 hrs. ago; avg. total dose 23.9	21 pts. (3 no morphine*) avg. latest dose morphine 26.0, 5 hrs. ago; avg. total dose 29.4	Only 1 pt. reported bad pain; he had morphine 30.0, 14 hrs. ago (compare with avg.)
Remarks on pts. where no further pain relief therapy wanted (morphine in mg.)	Avg. total morphine in 38 pts. (1 no morphine*) 28.1; latest dose 7.4 hrs. ago (avg.)	Avg. total morphine in 30 pts. (11 no morphine*) 27.5; latest dose 6.5 hrs. ago (avg.)	Avg. total morphine in 30 pts. (10 no morphine*) 26.1; latest dose 6.4 hrs. ago (avg.)	Avg. total morphine in 21 pts. (2 no morphine*) 30.1; latest dose 5.1 hrs. ago (avg.)	8 pts. had no morphine here. Others received only 1 dose; (for size and time see above)

* Not included in the average.

Ten of 225 patients who were approached had to be discarded from this consideration because they were unconscious or not mentally clear. Nine of these had penetrating head wounds. If all penetrating head wounds are excluded, only one patient out of the other 201 seriously wounded patients was not alert and mentally clear at the time of examination, and, accordingly,

had to be eliminated from this study, an interesting point in the light of the puzzlingly low incidence of pain found.*

In Table I the data are broken down into considerable detail, for those who are interested in the composition of the material on which conclusions are based. The nature of these observations is such, however, that it will be safest to confine the attention largely to the over-all effects rather than to details of questionable significance. In line with this it is interesting to observe that:

69 patients, or	32.1%, had no pain
55 patients, or	25.6%, had slight pain
40 patients, or	18.6%, had moderate pain
51 patients, or	23.7%, had bad pain
Total 215	100.0%

Naturally, a close parallelism exists between the number wanting pain relief medication and those reporting bad pain:

Bad pain reported:	
Yes.....	51 cases, or 23.7%
No.....	164 cases, or 76.3%
Pain relief therapy wanted:	
Yes.....	58 cases, or 27.0%
No.....	157 cases, or 73.0%

This close agreement of those reporting bad pain and those wanting pain relief therapy offers supporting evidence that the pain was accurately characterized.

Of the 51 patients who reported bad pain, five had had no morphine, the remaining 46 averaged 24.5 mg. for the most recent dose (compare with the average size of the most recent dose for each of the several groups), and averaged 30.5 mg. for total dose. Of the 157 who did not want further pain relief medication 32 had had no morphine, the remaining 125 averaged 27.3 mg. for total dosage. The time since the most recent dose of morphine was administered is comparable in the two groups: those who had bad pain and those who did not want further pain relief (Table I). Likewise, comparable are the total doses of morphine in the two groups. These data indicate that the patients with bad pain are not to be explained as having received less morphine or having gotten it longer ago than those who did not want further pain relief therapy.

In round numbers, the following percentages of patients in the various groups said they had bad pain:

Penetrating cerebral wounds.....	7%
Penetrating wounds of the thorax.....	12%
Extensive soft-tissue injury.....	16%
Compound fractures of long bone.....	24%
Penetrating abdominal wounds.....	48%

* A badly injured patient who says he is having no wound pain will protest as vigorously as a normal individual at an inept venipuncture. It seems unlikely that the freedom from pain of these men is to be explained on the basis of any general decrease in pain sensitivity.

Evidence that morphine is too often given by *rote*, and not according to the pain present, is found in the fact that bad pain was reported four times as often in the penetrating abdominal wounds as in penetrating wounds of the thorax, yet there is no important difference in the quantity of morphine administered to the two groups.

Abdominal wounds, on the basis of actual records, are, thus, found to cause far more pain at the time of entry into the Forward Hospital than other wounds do. Probably this great pain is due at least in part to spilling of blood and intestinal contents into the peritoneal cavity. Perhaps infection also has a part in increasing the pain.

Three-quarters of badly wounded men, although they have received no morphine for a matter of hours (Table I), have so little pain that they do not want pain relief medication, even though the questions raised remind them that such is available for the asking. This is a puzzling thing and perhaps justifies a little speculation. It is to be remembered that these data were obtained entirely from wounded soldiers. A comparison with the results of civilian accidents would be of interest. While the family automobile in a crash can cause wounds that mimic many of the lesions of warfare it is not at all certain that the incidence of pain would be the same in the two groups. Pain is an experience subject to modification by many factors: wounds received during strenuous physical exercise, during the excitement of games, often go unnoticed. The same is true of wounds received during fighting, during anger. Strong emotion can block pain. That is common experience. In this connection it is important to consider the position of the soldier: His wound suddenly releases him from an exceedingly dangerous environment, one filled with fatigue, discomfort, anxiety, fear and real danger of death, and gives him a ticket to the safety of the hospital. His troubles are about over, or he thinks they are. He overcompensates and becomes euphoric, as Douglas Kelling has found. Whether this actually reduces the pain remains unproved. On the other hand, the civilian's accident marks the beginning of disaster for him. It is impossible to say whether this produces an increased awareness of his pain, increased suffering; possibly it does.

Evidence has been presented above that morphine has not been given with reasonable accuracy to those needing it: doses given do not adequately parallel the pain present; delayed morphine poisoning, and the not uncommon tendency of some months ago to overdose point the need for improvement in the use of morphine. If it is borne in mind that almost the sole justification for the use of morphine is severe pain, and inquiry made concerning the need of a given patient before administering it, the situation will be improved.

TREATMENT OF PAIN: USE OF MORPHINE

Elementary as the following points may seem to the informed, constant repetition of them was found to be necessary:

Administration.—a. Dosage. Nearly the maximum analgesic effect of morphine is produced by smaller doses than generally supposed: Morphine $\frac{1}{4}$ gr. (15 mg.). Larger doses chiefly cause undesirable side-effects. They impair the body's power to overcome adverse situations. Usually morphine is not to be administered in greater than $\frac{1}{4}$ gr. (15 mg.) single dose. Use only small doses in patients to be transported by air, $\frac{1}{8}$ gr. (8 mg.) to $\frac{1}{6}$ gr. (10 mg.). Respiratory depression here is particularly undesirable (allay apprehension and fear of the first ambulance plane flight with barbiturates).

b. Route. Subcutaneous or intramuscular injection is employed when a gradual, prolonged effect is sought. This route is avoided when the peripheral circulation is slowed by cold or low blood pressure (see discussion below of delayed morphine poisoning in battlefield casualties). A better choice in such cases is intravenous injection. This is the best route also when immediate pain relief is wanted, or when delayed absorption might prove harmful, as in anticipated or developing shock. When injection is impossible (no syringe) morphine $\frac{1}{4}$ gr. (15 mg.) may be held under the tongue until it is dissolved.

Indications. The only really important use for morphine is to relieve severe pain. Use aspirin or codeine for mild pain. In the absence of respiratory depression, head or chest wounds do not contraindicate the use of small doses of morphine, if these or associated wounds cause pain. The use of morphine in preanesthetic medication has been greatly overdone.

Contraindications. a. Morphine will not be used as a sedative for "the jitters" or for "nervousness," in manic or hysterical states, for allaying fear, for promoting sleep (unless pain is present). Such use cannot be defended. For these conditions better agents are available (phenobarbital or pentobarbital sodium or paraldehyde). Neither is morphine to be used for controlling the restlessness associated with hemorrhage.

b. Morphine will be avoided (except where pain is present) as a routine agent in the preanesthetic medication of seriously wounded patients. Anesthesia is usually easy to induce in them, in any case.

c. Morphine will not be administered in the field to a patient who must walk back to the Aid Post. At the Aid Post it will not be given to the wounded man who must at once be evacuated to the rear as "walking wounded." Such may become confused, lie down along the evacuation route, and go to sleep. Evidence is accumulating that nausea following morphine administration is more frequent and more severe in ambulatory patients than in patients at rest lying down.

d. Morphine is contraindicated in shock unless pain is present. (See description below of effects morphine has on the respiration, circulation and fluid balance.)

e. Morphine is widely recognized to be dangerous in conditions of low metabolism, as in hypothyroidism.

f. Morphine is largely destroyed in the liver; therefore, it should be

used with great caution, if at all, in the presence of liver disease, as infectious jaundice.

g. Morphine will be used with great caution, if at all, when even minor degrees of anoxia might be dangerous, as in circulatory impairment, or when the respiration is already impaired, as by pneumothorax, hemothorax, or pleural effusion, when mechanical obstructions of the air-way are present or when central depression exists, morphine is ordinarily contraindicated.

Poisoning. This is first characterized chiefly by slow respiration and pin-point pupils. The outstanding serious effect of overdosage with morphine is respiratory depression, with anoxia. This is followed by circulatory damage. Less severe poisoning than the above, even therapeutic doses, often complicate treatment of the patient: morphine, in causing anorexia, nausea and vomiting, limits the intake of food and fluids by mouth and increases fluid loss in vomitus and sweat. Severe constipation is produced.

Delayed Morphine Poisoning in Battle Casualties. a. When the peripheral circulation is sluggish or inactive, as it may be in patients who are chilled or who have low blood pressure, subcutaneous injections of drugs are poorly absorbed. This was frequently observed to be the case in the Italian campaign.¹ Subcutaneous injection of morphine, under circumstances where absorption fails, does not relieve the pain of wounded men. Repeated injections, sometimes over a period of many hours, are not absorbed until finally, by shock therapy and warmth, the circulation is reestablished in the skin and subcutaneous regions. All of the unabsorbed deposits of morphine are then taken up by the active circulation so rapidly that signs of morphine poisoning previously not present then appear, as shock is overcome.

b. Although the intravenous use of morphine is desirable and would eliminate the problem, such use is not ordinarily practicable under outside field conditions. In this case, intramuscular injection followed by massage is the choice. All morphine injections should be made low enough on an extremity so that a tourniquet can be placed proximal to them if poisoning develops. Care is to be exercised in recording dose used, time given, and site of injection.

Treatment of Morphine Poisoning. Realization that morphine intoxication may have a rather abrupt onset many hours after the last morphine injection, under the circumstances discussed above, is a considerable help in recognizing the problem at hand. Correct diagnosis leads to prompt and effective treatment. A tourniquet, intermittently loosened, is placed proximal to the site of the injection. Primarily, the treatment of morphine poisoning consists in the effective prevention of anoxia. This is best accomplished by oxygen administration, with artificial respiration (if necessary) easily carried out with the aid of a closed anesthesia apparatus by means of intermittent bag pressure, with carbon dioxide absorption. Atropin $\frac{1}{60}$ gr. (1 mg.) intravenously may be of value. Ephedrine $\frac{1}{2}$ gr. (30 mg.) intravenously has some value as a central stimulant. It may help to support a falling blood pressure. Hypertonic glucose intravenously is a good diuretic and aids in

excretion of morphine by the kidneys. Body heat should be conserved. If coma develops, a gastric tube should be inserted in order to eliminate the possibility of aspiration of gastric contents. Moreover, frequent change of position is of value in reducing the later appearance of pulmonary complications. The treatment is supportive while the morphine overdose is largely destroyed in the body.

TREATMENT OF PAIN: MISCELLANEOUS MEANS

Regional Nerve Block. Various appropriate regional nerve blocks are of use. Outstanding here is the use of intercostal or paravertebral nerve block for controlling the pain of chest wall injury. This is followed by pulmonary ventilation more nearly normal in character. These blocks are so easily and quickly carried out, and afford such striking relief, it should be widely used. The usefulness of the local injection of procaine in the presence of some sprains is well-established.

Proper Splinting and Bandaging. The need for adequate wound support is so obvious as to require little comment, yet a common needless cause of severe pain is the swelling of the lower leg and foot in the case of fracture of the long bones of the extremity. The shoe should always be unlaced and slit if left on. Failure to observe this has led to many hours of acute suffering in patients who get prompt relief when this is done.

EMOTIONAL FACTORS AS WELL AS PAIN REQUIRE TREATMENT

The circumstances that have led to the wound may have been associated with anxiety; with emotional stress; with grief from the loss of friends; with fear; and these have often been exaggerated by the sights and sounds of prolonged combat, coupled with the physical discomforts of exposure to the weather, inadequate food and fluid intake, loss of sleep, exhaustion, as well as by pain. On top of all this the newly wounded man suddenly has to face the consequences of his wound: His arm is injured—will he lose it? There is blood around his genitals—will he be impotent? That wound in his chest—is he going to die? Given half a chance, indications of great mental agitation come out in a rush, from men who have been lying quietly, often seemingly asleep. Others react to this inner turmoil by restlessness and occasionally by manic states. (See the case referred to below.)

It is unlikely that lives are lost by the busy medical officers disregard of these mental and emotional factors at this early period in the patients' care; but what effect such disregard will have on the patient's later course has not yet been adequately considered. Thoughtful discussion of their cases with a few wounded men in any preoperative ward will show that much needless suffering results from neglect here. Neglect of these emotional problems at this time may have a profound effect on the patient's attitude toward his wound and to return to duty. Important from the military viewpoint is the inescapable fact that the patient's permanent outlook is powerfully and lastingly influenced by events at this time. Examples: The un-

warranted lighthearted statement by a medical officer that the patient will go home now that he is wounded, although later proven untrue, has done its damage, and it becomes in many cases impossible to reestablish the qualities of a good combat soldier in the healed patient. A disease labelled "shell shock" is often incurable; whereas if it be called merely exhaustion, a good response to treatment is obtained, *etc.* The early hours after wounding are important for establishing a point of view in the patient that will be of help in his early return to duty. More study of this period by psychiatrists is needed.

Part of the difficulty with the treatment of the distress of the wounded is that morphine is often employed in an attempt to treat conditions that will not respond to it however large the dose.^{2*} Patients are described as "writhing in pain," and large doses of morphine administered when the real problem is restlessness from cerebral anoxia, or excitement from fear and apprehension. In the former case correction of the oxygen shortage, in the latter, sedation, as with barbiturates, is indicated, not morphine.

Certainly, no one wishes to minimize the importance of adequate pain therapy (morphine): but there is too little realization that treatment of the actual pain present is only part of the job to be done. Wounded men need sedatives of the barbiturate type as well as narcotics. At times *small doses of both types of agent will accomplish what large doses of either alone will fail to do.*

Use of barbiturates in treating the agitation encountered in the wounded is illustrated by the following example:

Case Report.—A husky 19-year-old soldier was wounded at the Anzio Beachhead by a mortar shell. Five hours later he was brought into the nearest hospital with a meat cleaver-like wound cutting through the fifth to 12th ribs near the vertebral column. He had bled a great deal (hemoglobin 9.5 Gm.; not yet completely diluted) and was cyanotic. Obsessed with the idea that he was lying on his rifle, he constantly struggled to get off the litter and complained bitterly of the "pain." Three attendants were necessary to keep him on the litter. Examination of the patient in any adequate sense was impossible. He appeared to be wild from pain. His wound supported such a belief. (Not only were eight ribs cut in two, and an open pneumothorax present, but later it was found that the lower lobe of the lung, the diaphragm, and one kidney had been lacerated by a broken rib end.) He had had no morphine for at least four hours, and it was planned to give him more; but since the situation was confused, it was decided to give him 150 mg. (2.5 gr.) sodium amytal by vein. This was done, and he at once quieted down and went to sleep. Obviously no morphine was needed.

The patient was rousable but remained quiet for the next hour, until he went to the operating room. During the quiet period he was examined, and catheterized, previously impossible, and found to have grossly bloody urine. Immediately after receiving the barbiturate his color improved strikingly, doubtless in part due to the cessation of great physical exertion and to the fact that instead of constantly yanking out his nasal oxygen tube, it stayed in place, and his blood pressure rose at once from 60 up to 80 mm. Hg., systolic. Before the barbiturate was given all agreed that the patient's condition was rapidly deteriorating; he turned for the better immediately after the

* A common error in civil medicine as well as in warfare.

amytal was given. The dose given would not have controlled pain. It is reasonable to conclude that his manic state was not due to pain.

In the group of patients that received a sedative during the course of this study, sodium amytal was used intravenously, not from choice but because it was the only barbiturate available at the time for intravenous use. Had it been available nembutal sodium would have been used. Whenever sedatives are employed in the wounded, it must be remembered that depleted, bled-out individuals, men in shock, appear to be extraordinarily sensitive to these agents. It is best not to exceed at a given time a single dose of one grain (60 mg.) of sodium amytal for intravenous use in such patients. This can be repeated after 15 or 20 minutes.

THIRST

The data contained in Table I are based entirely on men who, although severely wounded, were not in shock. In these men thirst often causes considerable distress; but on the basis of records kept on 50 of these patients it is nearly always less a cause of discomfort than the wound. In the case of men in traumatic shock thirst rises to first place as a cause of suffering. Men in shock complain bitterly of thirst; they much less frequently complain of pain.

The administration of fluids by mouth is undesirable in patients who are soon to be anesthetized. Some relief is given by sponging-off the lips and by mouth rinses. Correction of the thirst requires restoration of the depleted blood volume, best achieved by intravenous fluid therapy.

Considering the amount of suffering caused by thirst in the badly wounded, it is curious that so little attention has been paid to ways of minimizing this symptom.

SUMMARY

Severe wounds in soldiers are often associated with surprisingly little pain. In order to get factual information on the incidence of pain, 225 freshly wounded soldiers were considered in five groups where the wounds were serious—compound fractures of long bones; extensive peripheral soft-tissue wounds; penetrating wounds of the thorax; penetrating wounds of the abdomen; and penetrating wounds of the cerebrum. None of these men was in shock at the time of questioning. As nearly as possible consecutive cases were considered. Ten of these had to be eliminated from consideration here because they were not clear mentally, or were unconscious. Nine of these ten had penetrating head wounds. If the head wound group is entirely disregarded, only one patient out of the remaining 201 severely wounded was not alert and clear mentally.

Of the various types of wounds considered, patients with penetrated abdomens have by far the most pain, possibly due to the spilling of blood and intestinal contents into the peritoneal cavity. Of all the patients considered only one-quarter, on being directly questioned shortly after entry in a

Forward Hospital, said that their pain was enough to cause them to want pain relief therapy; three-quarters did not need such relief. This was the case notwithstanding the fact that the most recent morphine had been administered hours before (Table I). Evidence is presented to show that the difference between the one-quarter that wanted pain relief therapy and the three-quarters that did not, cannot be explained by differences in dosage or timing of the morphine administered. Data are presented to show that morphine is too often administered by *rote* and not according to the patient's need. The data carry the strong implication that morphine is too often used in the belief that severe wounds are inevitably associated with bad pain—clearly not the case. The use of morphine in the treatment of pain is considered in detail.

It was observed that the excitement and hyperactivity occasionally encountered in the wounded had its origin in some cases not in pain but in cerebral anoxia, and more commonly in mental distress. Use of a small dose of a barbiturate provided great relief in the latter type of case. A small dose of a barbiturate in addition to a small dose of a narcotic will accomplish what large doses of either alone will often fail to do. Barbiturate sedation offers a real addition to the treatment of the wounded man. He often needs the type of mental depression produced by barbiturates in small dose as much as he needs the pain depression produced by morphine.

The man in shock complains far less frequently of wound pain than he does of the great distress produced by thirst.

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RETROPERITONEAL (MESENTERIC POUCH) HERNIA

CASE REPORT

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THE CORRECT DIAGNOSIS, and the successful surgical treatment of an unusual intra-abdominal hernia is of sufficient rarity to record it. The case is all the more interesting since the primary anomaly was associated with a secondary one—a giant Meckel's diverticulum. The history was unusual in that it suggested the presence of a duodenal ulcer and recurrent intestinal obstruction. The roentgenographic findings were indeed bizarre.

Case Report.—A 29-year-old soldier was admitted to a General Hospital in Assam, March 15, 1944, with a chief complaint of upper abdominal pain. He had been in excellent health except for indigestion until March 2, 1944, when he developed malaria. He received antimalarial therapy and was returned to duty March 12, 1944.

On March 13, 1944, he developed sudden acute pain in the right upper abdomen. He was nauseated but did not vomit. The pain, which was sharp and intermittent, began gradually to subside after one hour, and within 24 hours he was comfortable. Following recovery he was hospitalized for study.

The past medical history was not remarkable. He had just recovered from malaria and had not completely regained his strength. He had never previously had abdominal pain of the type recently suffered, but he had had a long history of "indigestion," and postprandial distress.

Physical examination revealed a well-developed Negro soldier whose sclera were tinted a lemon-yellow, presumably from the atabrine. The heart and lungs were negative to auscultation and percussion. The abdomen was not distended and no unusual tenderness was present, nor were any definite masses palpated.

Temperature and respiration were normal, red blood cell count was 3,150,000; the hemoglobin 6.5 Gm. per 100 cc.; and white cell count 5,600. The Kahn was negative. There was no evidence of sickling of the red cells. Two stools were positive for occult blood.

On March 23, 1944, while in the hospital, the patient had a second attack of sharp intermittent right upper quadrant pain similar to that which he had suffered ten days previously, except that this time he vomited. It developed soon after breakfast and was severe. It was mainly in the epigastrium and right upper quadrant, and the area remained hyperesthetic following subsidence of the acute pain.

Following recovery from this attack roentgenologic studies were made. The first gastro-intestinal series revealed a normal stomach. There was slight duodenal irritability which was considered reflex in origin. An air and fluid level was seen fluoroscopically in the region of the hepatic flexure of the colon (Fig. 1). Because of this a barium enema was introduced. This disclosed an anomaly in the ascending colon and hepatic flexure. The latter was depressed and shifted medially. The ascending colon lay close to the spine. There was no evidence of an obstructing lesion of the colon. The air and fluid level was easily identified above the hepatic flexure in the region of the gallbladder. The gallbladder was found to be normal by cholecystography.

A small intestinal study, using distilled water and barium, was then made. Fluoroscopic examination of the small intestine 30 minutes after the study was begun, revealed the head of the barium column in the region of the midileum. It was seen just entering

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the gas-filled shadow (Fig. 2). The afferent ileal loop ascended from its normal position in the lower abdomen into the right upper quadrant. In this area the barium seemed to spill across a kinked portion of the intestine into a dilated loop of ileum, which was the site of the air and fluid level (Figs. 3 and 4).

Manipulation of the bowel, under fluoroscopic guidance and changing the patient's position, suggested that the ileum was fixed in this abnormal position. It was obvious



FIG. 1



FIG. 2

FIG. 1.—Roentgenogram showing the air and fluid level in the region of the hepatic flexure.

FIG. 2.—Roentgenogram showing the head of the barium column in the region of the midileum, and just entering the gas-filled shadow.



FIG. 3



FIG. 4

FIGS. 3 AND 4.—Roentgenograms showing the spilling across a kinked portion of the intestine in the dilated loop of ileum, which was the site of the air and fluid level.

that this was the site of an incomplete intestinal obstruction with proximally dilated ileum. The peculiar tense contour of the barium-filled bowel strongly suggested that the loop was enclosed in a membrane or sac. The picture was compatible with the presence of an intra-abdominal hernia, and suggested, in addition, a large dilated Meckel's diverticulum. *Roentgenologic Conclusions:* Partial small intestinal obstruction associated with an intraperitoneal hernia, which also includes a greatly enlarged Meckel's diverticulum.



FIG. 5.—Photograph showing the giant Meckel's diverticulum exposed upon opening the sac.

Operation.—April 28, 1944: An exploratory celiotomy was performed under continuous spinal anesthesia. Right paramedian incision. Surrounding the lower ileum was a translucent peritoneal sac which seemed to constrict the small bowel, for the small bowel proximal to the entrance into the sac was dilated and thickened. The sac was opened and a giant Meckel's diverticulum was exposed (Fig. 5). The diverticulum was bound down to the right posterior lateral abdominal wall behind and above the hepatic flexure of the colon. The small bowel from proximal to the diverticulum was also greatly dilated. The sac containing the small bowel and diverticulum seemed kinked on itself and rotated to the right.

The sac was widely opened and the structures more clearly identified. The bowel, from a distance 5 cm. proximal to its entrance to the sac and an equal distance distal to its emergence from the sac, was freed from all surrounding attachments. The entire area of bowel, including the sac, was then excised and intestinal continuity reestablished by end-to-end anastomosis (Figs. 6 and 7). All parietal denuded areas were carefully peritonized. Ten grams of sulfanilamide crystals were placed in the peritoneal cavity and the wound closed by layer suture.

DISCUSSION.—The hernia involved the distal portion of the ileum, there being not more than 30 cm. of small bowel from the point of exit from the sac to the ileocecal valve. The sac was thin, nearly transparent, and was avascular.

It is obvious that the lesion belonged to the general group classified as retroperitoneal or intraperitoneal herniae. Originally considered to have been

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FIG. 6



FIG. 7

FIGS. 6 AND 7.—Photographs showing the anterior and posterior aspects of the gross specimen, consisting of the entire area of bowel, including the sac, which was excised.

herniations into intraperitoneal fossae, especially the duodenal fossae, they are now generally accepted as being due to developmental defects. Andrews¹ has shown these herniations to be the result of "imprisonment of the small intestine beneath the mesentery of the developing colon." Callender, Rusk and Nemier² have confirmed Andrews' concept, and have suggested that an hernia such as the one being reported be called "hernia behind the ascending mesocolon." The recent report by McCarty and Present³ would tend to confirm these conclusions.

The trapped portion of the ileum lay behind a mesenteric veil of the ascending colon which formed the sac. No large blood vessels were encountered either at the entrance or exit from the sac, as is usually the case. This was a happy circumstance, for it permitted of resection without danger of interfering with the blood supply to the remaining intestine.

It must be presumed that in the primary rotation of the intestine and the subsequent movement of the large bowel to the right and downward, the involved bowel became imprisoned between the mesentery of the colon.

The history suggestive of duodenal ulcer and intestinal obstruction is not unusual, although in numerous instances the lesion causes no gastro-intestinal symptoms. One such lesion, reported by Addinell Hewson some years ago, was discovered by one of us at the dissecting table. Those that give rise to symptoms must be treated surgically, the exact operative procedure depending upon the findings at operation. There can be little doubt but that the large Meckel's diverticulum was the major cause of the obstructive phenomena. The patient here reported made an uneventful recovery and has remained symptom free, and on full duty.

SUMMARY

An instance of retroperitoneal hernia is reported. It was unusual in that it involved only a limited portion of the ileum and, also, that the sac was avascular and no large blood vessel was present at either the entrance or exit from the sac. In addition, there was present a giant Meckel's diverticulum which was the cause of the patient's obstructive symptoms. Complete resection and anastomosis has resulted in recovery and relief from all symptoms.

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CYSTIC DISEASE OF THE LIVER

REPORT OF A CASE

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CYSTIC DISEASE of the liver, cystic liver, cystic degeneration of the liver, polycystic disease of the liver and congenital cysts of the liver are terms used to describe the presence of numerous nonparasitic cysts, of varying size, occurring in the liver.

Multiplicity of the cysts, according to Rolleston,¹ and Weiss,² serves to distinguish cystic disease from the condition of a simple solitary cyst, often referred to as a retention cyst. This difference may be only apparent, as it has been suggested that a solitary cyst may be the end-product of cystic disease, wherein, because of growth and pressure, the contiguous walls of the multiple cysts disappear, thus forming a large, unilocular structure. Surgically speaking, however, the difference can be considered real. Simple solitary cysts are localized, are usually circumscribed and occasionally possess a pedicle. The result is that surgical treatment of solitary cysts is far more often possible than in cases of cystic disease, wherein the lesion is more generalized with reference to the liver. Marsupialization, for example, can be accomplished with fewer technical difficulties in a case of simple cyst than would be possible in a case of cystic disease. If surgical treatment is undertaken at all in cystic disease, extirpation of the involved region is usually necessary, in which case the technical difficulties are considerably increased.

Case Report.—A white male, a blacksmith and welder, age 39, was first seen at the Mayo Clinic on August 9, 1944. His family history was noncontributory to his present illness. In 1924, he had been told that he had chronic lead poisoning but, when he was questioned concerning this, he was unable to remember much about it. In 1927, tonsillectomy had been performed.

The patient's chief complaint was a feeling of fullness and dull aching in the epigastrium. This distress had been present for four years and was progressively becoming worse. He associated the onset with an upper respiratory infection, following which he had noted a very mild sense of fullness in the abdomen. Shortly after the onset, he began to associate this sense of fullness with the taking of meals. Almost immediately after taking of food, he would experience pressure and aching in the epigastrium, which would last for about two hours and gradually subside. It was at this time, also, that he became aware of an increase in the size of his epigastrium, also following the ingestion of a meal. Except for the two hours of discomfort following a meal, the intervals between the taking of food were symptomless. About three years ago he noted that the increase in size of his epigastrium persisted whether or not food was taken. The symptoms progressed until at the time of his examination at the

Clinic he was aware of a large mass in the epigastrium and was unable to ingest even a moderate amount of food without feeling discomfort. Also, in addition to the sense of fullness and pressure in the epigastrium, he was then experiencing nausea after meals. There was no history of loss of weight; his appetite was good; there never had been any vomiting nor diarrhea and he was unable to recall that he had ever had any tarry or bloody stools. A systemic inventory elicited no additional complaints.

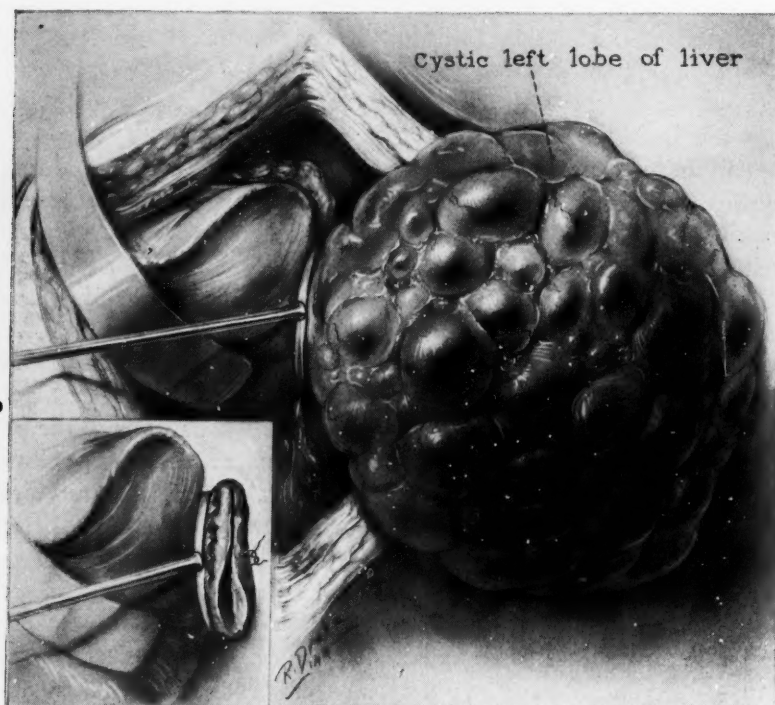


FIG. 1.—Left lobe of the liver involved by cystic disease; tourniquet applied around its pedicle. Inset: Removal of left lobe of liver and closure of pedicle with interrupted mattress sutures.

On physical examination, the patient appeared to be in excellent health. His normal weight was between 185 and 190 pounds (83.9 and 86.2 Kg.). His weight at the time of the examination was 180 pounds (81.6 Kg.). When he was in the recumbent position a swelling could be seen in the epigastric region. On palpation, the swelling seemed to be a cystic tumor with an irregular surface. Except for bilateral nerve deafness, other physical findings fell within normal limits.

The routine laboratory findings were within a normal range. A roentgenogram of the stomach showed the presence of a large extrinsic mass, the stomach itself being normal.

It was thought that the patient might have a pancreatic cyst. Accordingly, the concentration of sugar in the blood was tested. It was found to be 112 mg. per 100 cc. of blood. The blood amylase was 160 units and the lipase was negative. The serum bilirubin was within a normal range. The dye test of liver function showed no retention of the dye. In spite of the normal results obtained in investigating the pancreatic function, it was thought that the epigastric tumor was probably a pancreatic cyst.

Accordingly, on August 12, 1944, operation was performed through a primary

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upper left rectus incision. Immediately, a portion of the mass, consisting of multiple various-sized cysts, presented itself into the incision. On further examination it was found that this represented the left lobe of the liver. Examination of the right lobe showed it to be normal in appearance. Palpation of both kidneys was then done and neither seemed to be cystic. By separating numerous adhesions from the mass, a rela-

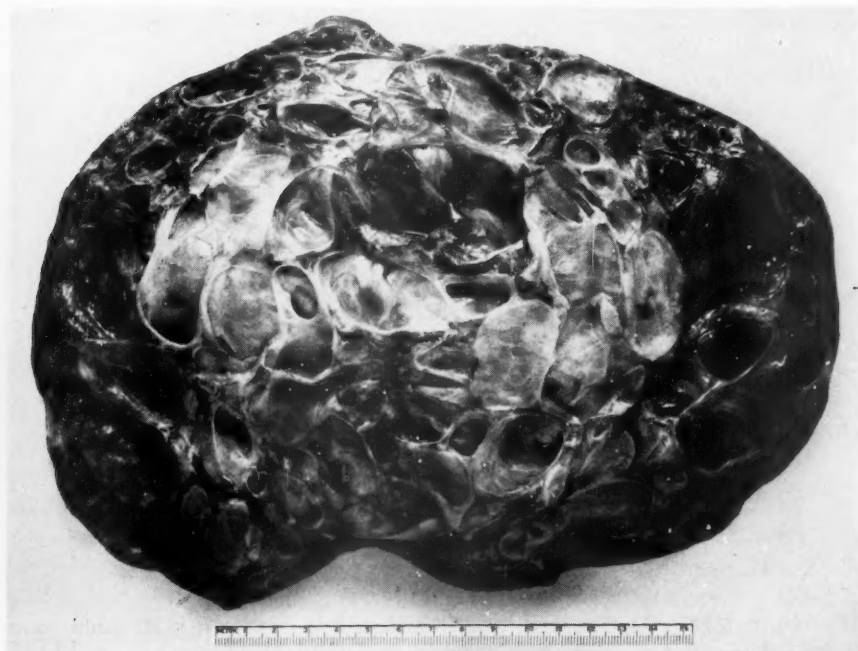


FIG. 2.—Cystic disease of the liver involving the entire left lobe.

tively narrow pedicle was encountered adjacent to the ligamentum teres. A Bethune pneumonectomy tourniquet was then applied around the pedicle (Fig. 1) and the entire left lobe of the liver was removed *en masse*. The remaining stump was closed with interrupted chromic catgut sutures. The tourniquet was then removed and there remained only minor oozing of blood from the stump. It was feared, inasmuch as the entire hepaticoduodenal and gastrohepatic ligaments were exposed in the procedure, that injury might have occurred to the common and hepatic bile ducts. Examination, and later clinical recovery, showed that no injury had occurred.

Five grams of sulfanilamide powder was sprinkled into the area and one double iodoform pack was placed to control what oozing might occur from the stump. Two Penrose drains were brought out through the incision.

The pathologist who examined the specimen stated that it was the entire left lobe of the liver (Fig. 2), weighing 1,005 Gm., and consisting of multiple cysts lined by epithelium of bile duct type (Fig. 3). The cysts varied from 8 cm. in diameter to those of microscopic size.

The postoperative convalescence was uneventful. On the eighth postoperative day, the gauze pack was removed. On the ninth day the patient was permitted to be up. The Penrose drains were removed, one on the tenth day, the other on the 11th day. The patient was dismissed from the hospital on the 13th postoperative day and was permitted to return to his home on the 15th postoperative day.

COMMENT

In addition to the fact that the left lobe of the liver was removed, this particular patient presented several interesting features. Involvement of the left lobe by nonparasitic cysts occurs much less frequently than involvement

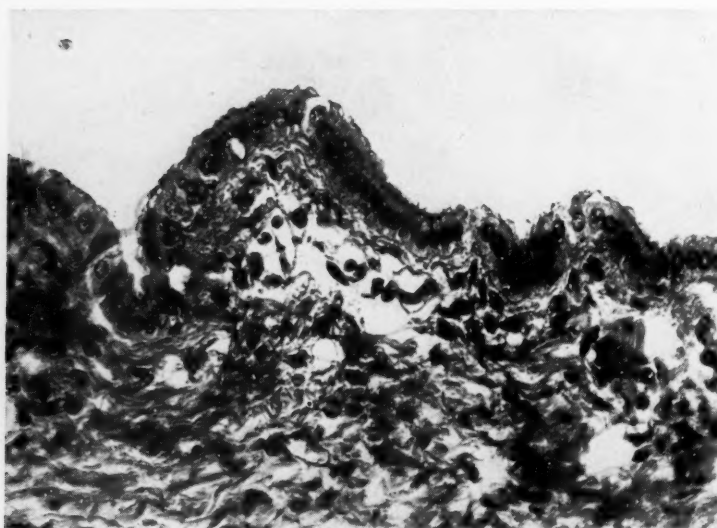


FIG. 3.—Bile duct epithelium lining the cystic cavities.

of the right lobe. McCaughan and Rassieur,³ in reviewing 80 such cases, including two of their own, found that 52 patients had cystic tumors in the right lobe, 11 in the left and two in the middle lobe. In six cases the entire liver was cystic. In nine cases the position was not mentioned. As will be discussed later, cystic disease of the liver is usually associated with cystic disease of the kidneys. This did not prove to be true in this case.

The general incidence of cystic disease is low. Ackman and Rhea⁴ stated that 11 cases of nonparasitic cysts were found in 6,141 necropsies.

A recent and extensive review of the literature was made by Davis,⁵ in 1937. He was able to gather data on 499 cases of nonparasitic cysts of the liver, including one of his own. In only 241 of these 499 cases were there multiple cysts or cystic disease. In the remaining cases the cysts were reported as being solitary and unilocular (187), solitary and multilocular (20), or unstated (51). Other reporters found a similar proportion to exist in the cases reviewed by them.

The age incidence shows the disease to be rarely discovered in infants and the newborn. Rolleston¹ suggested that there may be some discrepancy in these findings because the disease is doubtless overlooked, since the involved liver in the newborn suggests fibrosis rather than cystic disease. He also suggested that since some cases have been associated with unrelated malformations, polydactylism, meningocele, *etc.*, a routine microscopic examina-

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tion of the liver in these cases would show that cystic disease is less rare than is now believed.

Since it is possible for cystic disease to be present and the condition to be compatible with good physical health, in most of the cases in the literature the patient was reported to be an adult. In the cases reviewed by McCaughan and Rassieur³ the average age was 33 years.

The disease occurs more frequently in the female than in the male, the ratio being three females to one male.

Most authors agree that the cause of the simple solitary cyst is some form of local obstruction in the biliary tract with a resultant retention type cyst. In cystic disease, however, opinion seems to be divided, since there are various hypotheses as to the pathogenesis. Four of the most prevalent will be discussed.

HYPOTHESES AS TO PATHOGENESIS

1. *Inflammatory*.—Mihalkowicz, Juhel-Renoy, Babinsky and Blackburn⁶ described the process as being due to pericholangitic inflammation leading to biliary cirrhosis with dilatation of the bile ducts. The inflammatory process during fetal life weakens the walls of the small bile ducts and they dilate, never to recover their normal size.

2. *Degeneration*.—Pye-Smith⁷ regarded the process as due to vacuolation of the hepatic cells, which then fuse with other similarly affected cells, leading to the formation of cysts. Pilliet⁸ regarded cystic disease as being the result of atrophy of the hepatic cells, which change into new bile ducts, which, in turn, develop into cysts.

3. *Tumor Hypothesis*.—Sabourin⁹ held that the cysts were cavernous biliary angiomas and regarded them as due to irritation, which leads to development of newly formed bile ducts; the latter fuse and dilate, forming larger cysts by a breakdown of the separating septa. Others have held that the condition was cystic sarcoma and adenoma or a cystic fibro-adenoma homologous to an ovarian cystadenoma.

4. *Developmental Hypothesis*.—This regards the condition as being congenital. Still¹⁰ suggested a malformation of some of the cells of the hepatic diverticulum in the embryo. These cells then go on to form cysts. Moschcowitz¹¹ described aberrant bile ducts in the fibrous tissue of the portal spaces of cystic livers, which were not present in normal livers. He, likewise, noted the presence of these structures in livers in cases in which the kidneys were polycystic. Moolten¹² regarded the entire process as being due to an immaturity of development and a fixation of differentiation. He cited Lewis as showing that in fetal growth in the 28-mm. embryo the perilobular bile ducts normally arise from the hepatic cords aligned along the outer surface of the periportal mesenchyme. The ducts thus formed are seen to connect freely with the hepatic trabeculae and also to intercommunicate, thus forming a plexus. With the further growth of the liver, however, the anastomoses normally become less numerous. In the liver examined microscopically by

Moolten, that of an eight-day-old infant that died of polycystic disease, he saw it to be similar to that seen in early embryonic life, even to the point of showing the presence of different heights of the epithelium lining the ducts. Thus, where the ducts were adjacent to the parenchyma, the epithelium was of a low cuboidal type; where they made contact with the periportal connective tissue, the epithelium was of a high cuboidal type. This, according to Lewis, is normal in the embryo. Other embryonal structures seen to persist in the liver examined by Moolten were: (1) The abundance of mesenchyme in the form of abnormally thick connective tissue in the portal fields; (2) numerous large caliber branches of the portal vein; (3) dilated and ramifying collecting bile ducts with numerous unfoldings of their lining epithelium surrounded by a dense connective tissue; and (4) portal fields, which varied greatly in size and which were totally irregular in distribution.

Grossly, in the adult the liver affected by cystic disease is fairly typical. The affected portion is usually enlarged and deformed by the presence of numerous cysts of varying sizes occurring on the surface. The cysts are surrounded by a capsule of well-formed fibrous tissue and are of varying shades of glistening blue. On section, the involved region is honeycombed by multiple independent cavities. The residual hepatic tissue is seen to be decreased, depending on the size and the number of cysts. If the cysts are opened, they usually contain clear albuminous fluid, which may be brown as the result of hemorrhage. They never contain any bile.¹

Microscopically, if the patient is an adult, the cysts are large and are surrounded by well-formed fibrous tissue. The epithelium lining the cysts varies with the size, and therefore the stage of development, of the cyst. Thus, in the larger type, the epithelium may be degenerated, absent or represented by a few flattened cells. In the medium-sized type it is cuboidal, and in the smaller cysts, columnar. Usually the hepatic cells are well-preserved.

All authors reviewed make special mention of the fact that cystic disease of the liver is usually associated with cystic disease elsewhere—notably in the kidney. When there are associated renal lesions, they are usually far more advanced than those that occur in the liver.

Moschcowitz reviewed 85 cases of cystic disease of the liver and in only ten did he find that the liver alone was affected. The converse, however, is not true, inasmuch as numerous reports of cystic kidneys without the presence of a cystic liver have been recorded. Luzzatto¹³ in 90 cases of cystic disease of the kidneys found only five in which the liver was primarily involved. Moolten stated in his review that approximately 19 per cent of cystic kidneys had associated cystic livers.

Besides the kidney, cystic disease of the liver has, likewise, been associated with cystic disease of the pancreas, spleen, ovary and lungs.

The disease is frequently associated with other malformations wholly unrelated in type; for example, spina bifida, meningocele, polydactylism, vesical anomalies, *etc.*

The clinical picture of cystic disease of the liver presents no pathognomonic

features. McCaughan and Rassieur, in their review of 80 cases of non-parasitic cysts of the liver, found that very few were diagnosed preoperatively. Conditions most often confused with hepatic cysts are ovarian tumor, hydrops of the gallbladder, cystic kidney and, as occurred in our case, pancreatic cyst. It is probable that the majority of patients who have cystic disease of the liver never seek treatment for the condition, inasmuch as their liver function is very rarely impaired. Because of the association of cystic kidneys, and because the disease is usually more advanced in those organs, symptoms of urinary disturbances might be the presenting complaint. If, in such a patient, polycystic kidneys are discovered, only then can a similar process be suspected in the liver. On the other hand, if the cystic liver has enlarged to the point where it encroaches on neighboring structures, giving signs and symptoms referable to those structures, and if those structures have been proved to be without any organic pathologic lesion, then cystic disease of the liver may be included in the list of possibilities.

The most notable feature about our own case was the absence of any signs of malignant or systemic disease in spite of the upper gastro-intestinal symptoms and the presence of a large upper abdominal mass. There was very slight loss of weight, no loss of appetite, no change in the blood findings and no palpable lymphadenopathy.

If a cystic liver has enlarged to the point of causing a palpable mass, the identity of which cannot be proved, then exploration of the abdomen would be advisable. On encountering such a lesion, two alternatives are possible: Either (1) the involved portion can be removed; or (2) nothing should be done. The decision to excise the lesion must be made only after several factors have been considered. The kidneys should be palpated. If they, too, are involved seriously, then there is no point in attempting to excise a portion of the liver; the hazards of this procedure are well-recognized.

If the patient has been asymptomatic in spite of the presence of the cystic liver and if removal of the tumor would involve too great a risk, then one would be justified in doing nothing. If, on the other hand, the tumor is interfering with the patient's well-being, the kidneys are without palpable involvement and removal of the lesion would not be too hazardous a procedure, then extirpation certainly is justifiable.

In America, the first recorded resection of the liver, according to Keen,¹⁴ was done by Tiffany in 1890. Keen himself, in 1892, resected a portion of the right lobe of the liver for a "cystic adenoma of the bile ducts weighing 113 Gm." Since then, resection of portions of the liver has been done a number of times. McCaughan and Rassieur, in reviewing 132 cases of non-parasitic cysts of the liver, found that excision of the involved portion had been performed in 29 cases, with a mortality rate of 17.2 per cent. Those authors make special note of von Haberer's¹⁵ case, in which he resected the entire left lobe of the liver, "which was the site of a cyst the size of a child's head."

SUMMARY

A case of cystic disease of the liver, in which the entire left lobe of the liver was removed surgically, is presented. The condition is discussed as to etiology, pathology, diagnosis and treatment.

As far as we were able to determine from the literature, this is the first reported case in which the entire left lobe of the liver was removed for cystic disease. The only other reported case of a similar nature was that of von Haberer, who, in 1908, removed the entire left lobe of the liver, wherein was a nonparasitic solitary cyst, which occupied the greater part of that lobe.

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CONGENITAL CYSTIC DILATATION OF THE COMMON BILE DUCT

FOLLOW-UP ON PREVIOUSLY REPORTED CASE AND REPORT OF ADDITIONAL CASE

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SINCE congenital cystic dilatation of the common bile duct (choledochus cyst) if untreated eventually leads to death, whereas, surgical intervention offers cure or improvement, continued reports of this rare lesion are warranted in order to emphasize its existence, methods of early diagnosis, and proper treatment. For this reason two cases of our own are presented and discussed, one a previously reported case with follow-up study and the other recently observed. In addition the literature on this subject since our previous review¹ is brought to date.

Case 1.—P. W., a white male, age 20, was admitted to the Jefferson Medical College Hospital July 11, 1941, with the chief complaints of pain in the right upper abdomen, jaundice and fever, recurring at varying intervals over a period of eight months. A mass, six inches in diameter, was palpable in the right upper abdominal quadrant.

Laboratory studies revealed a moderate anemia (hemoglobin 65 per cent); grossly bile-stained urine; rapid sedimentation rate (31 mm. within one hour); low prothrombin time (38 per cent of average normal); impaired liver function (15 per cent bromsulfalein dye retention); hyperbilirubinemia (3.5 mg.); nonvisualization of the gallbladder by oral cholecystography; and displacement of the stomach, duodenum, jejunum and colon on roentgenologic examination of the gastro-intestinal tract with barium (Fig. 1, A and C). Peritoneoscopy revealed a large cystic retroperitoneal mass near the right kidney.

The patient was operated upon July 31, 1941, the preoperative diagnosis being retroperitoneal mass, probably choledochus cyst, with obstructive jaundice. A large choledochus cyst together with the gallbladder and cystic duct were excised *en masse*, and the right and left hepatic ducts implanted into the first portion of the duodenum over No. 18 F. catheters. Uneventful recovery ensued, and the patient was discharged on the 37th postoperative day. The catheters were removed through a gastroscope during a second hospital admission 11 weeks postoperatively.

Follow-up study, conducted over a period of three years and eight months, reveals that the patient's general health has remained excellent. He has been working steadily as operator of a metal planer for the past three years and has been happily married for two and one-half years. He is free of pain, jaundice, abdominal masses and fever, and has gained five pounds in weight. Bromsulfalein liver function study performed on March 13, 1945, revealed no dye retention, and the van den Bergh reaction was negative direct with serum bilirubin 1.0 mg. Gastro-intestinal series and barium enema study at this time revealed normal position of the stomach, small intestines and colon (Fig.

1, B and D). There was questionable regurgitation of a very slight amount of barium into the hepatic ducts.

Case 2.—E. K., a white female, age 58, was admitted to the service of Dr. Thomas A. Shallow at the Jefferson Medical College Hospital, July 13, 1944, with the chief complaint of abdominal swelling.

During the year prior to admission the patient noticed that her abdomen was gradually and persistently increasing in size. This enlargement was not associated with any discomfort or pain. Every three or four weeks she also noticed that her urine

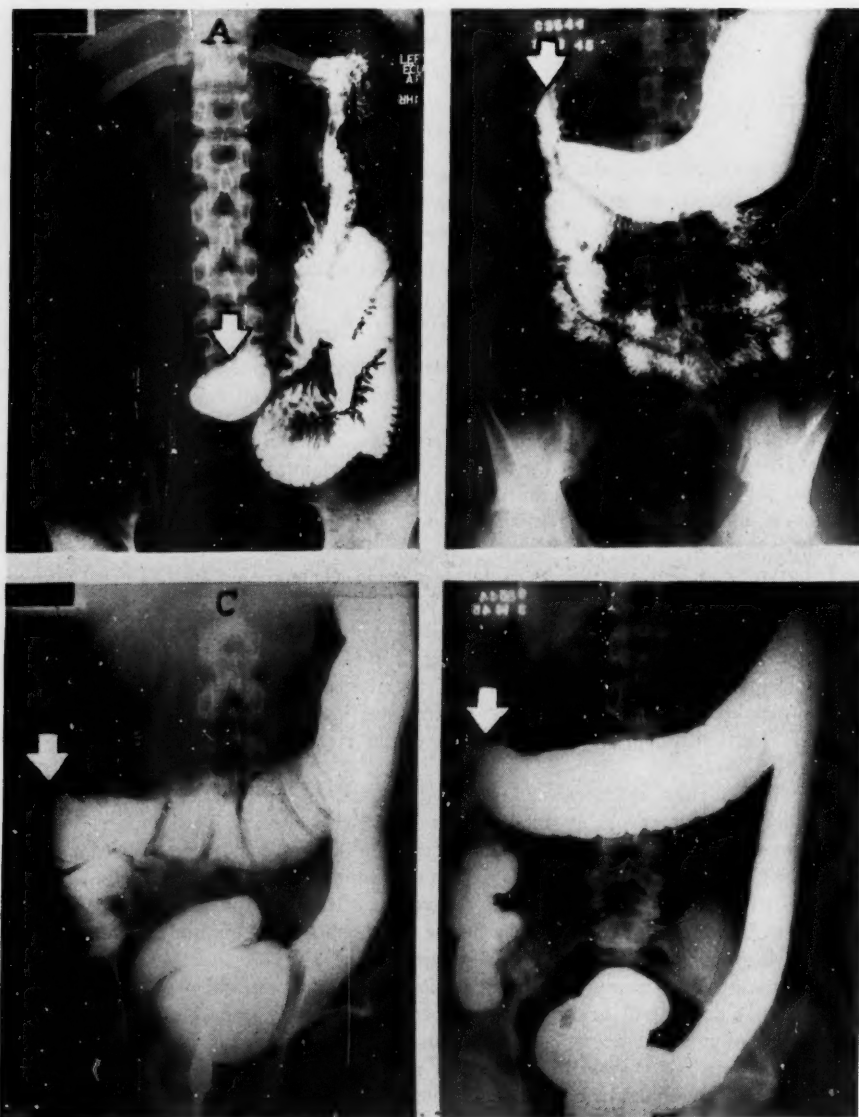


FIG. 1.—Roentgenologic studies in Case 1, in which the cyst was excised. Arrow in (A) shows displaced stomach and duodenum preoperatively, and in (B) the return to normal position postoperatively. Arrow in (C) shows displaced hepatic flexure of colon preoperatively, and in (D) the return to normal position postoperatively.

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became darker than usual and her stools lighter in color for several days, but no jaundice was observed. There was no weight loss and her general health had remained excellent.

A review of the remaining systems disclosed a recent episode of senile vaginitis treated successfully by a gynecologist. The past history was otherwise uneventful for serious illnesses or operations. The family history failed to reveal any member ever having suffered from a similar ailment.

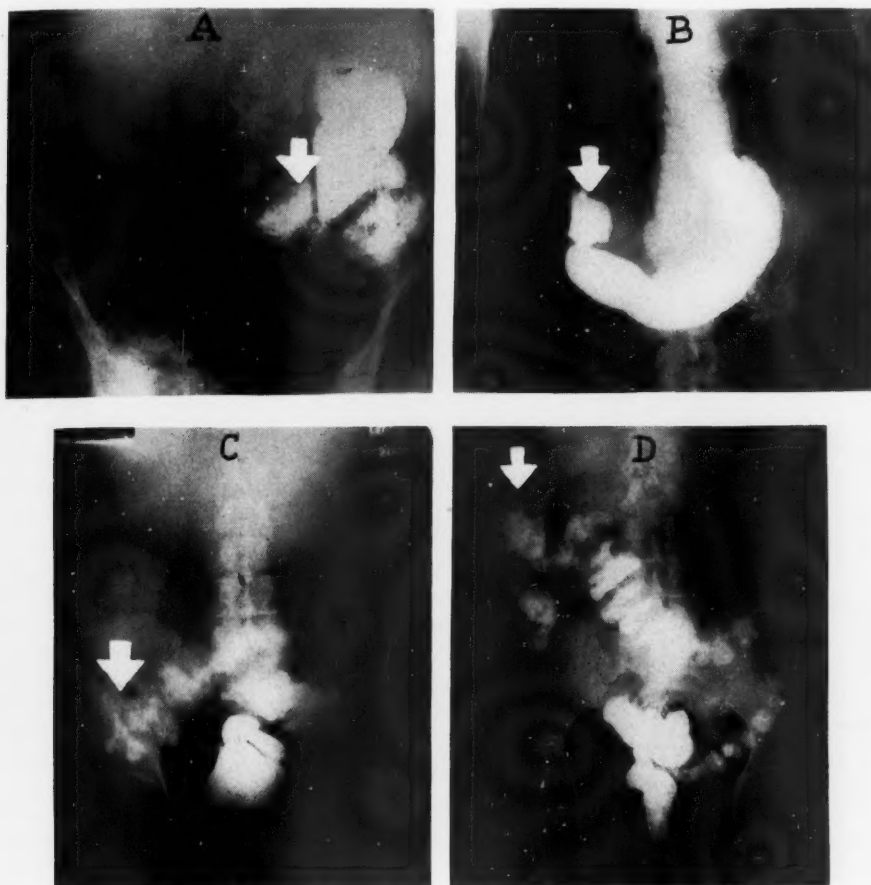


FIG. 2.—Roentgenologic studies in Case 2, in which the cyst was anastomosed to the duodenum. Arrow in (A) shows displaced stomach and duodenum preoperatively, and in (B) the return to normal position postoperatively. Arrow in (C) shows displaced hepatic flexure of colon preoperatively, and in (D) the return to normal position postoperatively.

Physical Examination.—The patient was a well-nourished middle-aged woman, who did not appear ill. The temperature, pulse, and respirations were normal. Blood pressure, 144/94. The scleras were moderately icteric and there was slight jaundice. Examination of the neck and chest was essentially normal. On inspection of the abdomen there was distention resembling that seen in the eighth month of pregnancy; the origin, however, appeared to be upper abdominal. The overlying superficial abdominal veins were slightly more prominent than usual. On palpation, a smooth, elastic, nontender, mobile mass was felt, which filled the entire upper abdomen, and extended to the level of Poupart's ligament on the right side and the lower costal margin on the left. This

mass moved slightly with respiration. Pelvic and rectal examinations as well as the extremities were normal.

Laboratory Studies.—Hemoglobin, 91 per cent; red cells, 4,700,000; white cells, 8,400, with polymorphonuclear cells 64 per cent, eosinophils 1 per cent, lymphocytes 32 per cent, and monocytes 3 per cent. Color index 0.96.

Routine uranalysis on four different days revealed very dark amber color; specific gravity ranging between 1.010 and 1.022; moderate albuminuria; no sugar; no acetone; and many white blood cells.



FIG. 3.—Appearance of cyst fluid in Case 2. The jar was filled one and one-half times (5,800 cc.).

Bromsulfalein liver function test showed 40 per cent dye retention. The van den Bergh reaction was positive direct with a serum bilirubin of 2.0 mg. The prothrombin time was 100 per cent of average normal.

Roentgenologic study of the gastro-intestinal tract with barium revealed that the stomach and duodenum were displaced markedly to the left and anteriorly by an enormous mass (Fig. 2A). The coils of small bowel were displaced downward and forward. The hepatic flexure of the colon was displaced downward to the level of the pelvic brim (Fig. 2C). There was no evidence of organic disease or obstruction in the gastro-intestinal tract.

The cholecystogram was indeterminate, but a questionable shadow which could have represented the gallbladder was noted anterior and lateral to the mass. No opaque or nonopaque calculi were noted.

Preoperative Course.—The patient was given a high carbohydrate, high protein, low fat diet supplemented by a pint of orange juice daily. In addition, 1,000 cc. of 10 per cent glucose in water with vitamin K mg. 3 were administered intravenously daily, and vitamin C mg. 50 and aminoids, one ounce, three times daily by mouth.

Following eight days of study and preparation she was operated upon with a preoperative diagnosis of choledochus cyst.

Operation.—July 20, 1944, Doctor Shallow: Under 20 mg. of pontocaine spinal anesthesia, an incision was made one inch below and parallel to the right costal margin, and the peritoneal cavity opened. A huge cyst which almost filled the entire abdomen was encountered. The duodenum was displaced medially and anteriorly, the transverse colon caudally, and the gallbladder laterally. The gallbladder was normal in size and contained no palpable stones. The liver, likewise, was of normal size and showed only slight cirrhotic change.

With a needle and syringe 10 cc. of thin dark brown fluid were withdrawn from the cyst which on culture yielded no bacterial growth in 48 hours. A suction trochar was then inserted and a gallon collecting jar was filled about one and one-half times (Fig. 3). Subsequent measurement of the fluid disclosed a total quantity of 5,800 cc., and chemical analysis revealed the presence of bile and a moderate amount of amylase.

Because of the age of the patient and the enormous size of the cyst, it was felt that extirpation carried an undue risk. Accordingly, anastomosis was performed between the most dependent portion of the deflated cyst and the first portion of the duodenum. While carrying out this procedure a biopsy specimen of the cyst wall was removed at the anastomosis site. A Penrose drain was inserted into the right kidney pouch and

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brought out the lateral pole of the wound which was then closed in layers. The patient remained in good condition throughout the operation which lasted one hour and 15 minutes.

Pathologic Examination of Biopsy Specimen of Cyst Wall.—The cyst wall consisted of fibrous tissue, 5 mm. thick, in which there were areas of recent hemorrhage. An epithelial lining was lacking (Fig. 4).

Postoperative Course.—The immediate response and convalescence were essentially uneventful. Wangensteen suction was instituted for the first three days, during which time the patient received glucose in saline intravenously, supplemented with vitamins C and K and amino-acids. She received 500 cc. of blood shortly after operation and also on the 10th and 18th days postoperatively. The drain was withdrawn during the seventh and eighth days. The wound healed without infection, and the patient was



FIG. 4.—Photomicrograph of wall of cyst in Case 2. ($\times 37.5$)

discharged on August 17, 1944, the 28th day postoperatively. At this time there was no evidence of abdominal enlargement and the serum bilirubin was 0.5 mg.

Subsequent Course.—Follow-up study February 15, 1945, approximately seven months postoperatively, revealed that the patient was entirely well, had a good appetite, and was free of abdominal swelling, jaundice or pain. The wound remained well healed. Roentgenologic study of the gastro-intestinal tract with barium showed the stomach, small intestine and colon in a normal position (Fig. 2 B and D). Cholecystogram failed to reveal a gallbladder shadow and there was no evidence of opaque calculi. Liver function study, March 21, 1945, eight months postoperatively, revealed 5 per cent retention of the bromsulphalein dye. At this time the van den Bergh reaction was negative direct and serum bilirubin 0.7 mg.

DISCUSSION.—Since our previous review of the literature¹ there have appeared case reports by Smith² (two cases), Gray,³ Swartley,⁴ Nitsche,⁵ and Hutchins and Mansdorfer.⁶ These, in addition to our own new case, bring the total authentic cases to 182. The report of Diebold⁷ is not available at present and for that reason is not included. The addition of these few reports adds little of significance to our recent analysis of 175 cases, and, therefore, a further analysis is not warranted at this time.

If the lesion is not suspected preoperatively it is important to recognize it promptly at celiotomy in order to avoid unduly long exploration and improper treatment. The frequent but not constant triad of symptoms and signs, namely, tumor (77 per cent), jaundice (70 per cent) and pain (59 per cent), should suggest the correct diagnosis if the lesion is kept in mind as a diagnostic possibility. Tumor and jaundice, which are the most constant features of the triad, were present in both of the authors' cases, but pain was absent in Case 2. The statement frequently seen in the literature that no relation exists between the size of the cyst and the severity of the pain is well borne out in this case. The importance of preoperative diagnosis is demonstrated by the fact that in 22 cases in which it was correct, or suspected, the mortality was 36 per cent, whereas, in 153 cases in which the diagnosis was incorrect, or none made, the mortality was 62 per cent. In each of our two cases the outcome was favorably influenced by the preoperative suspicion of the lesion, improvement of the patient's condition prior to operation and properly selected surgical treatment.

Anastomosis of the biliary and intestinal tracts is essential to prevent biliary cirrhosis, cholangitis, liver abscess, hemorrhage, or rupture of the cyst. The cyst itself may be anastomosed, as first advocated by Bakes,⁸ in 1907, or excised and the remaining choledochus, common hepatic duct or both hepatic ducts joined to the intestine; or the gallbladder may be anastomosed when a free communication exists between this organ and the cyst. Primary performance of this group of procedures carried a mortality of 27 per cent in 60 cases, whereas, external drainage of the biliary system followed by secondary anastomosis to the gastro-intestinal tract carried a mortality of 29 per cent in 24 cases. The latter procedure entails a slightly higher mortality because of the formation of an external biliary fistula, hemorrhagic tendency due to low prothrombin values, and the extra burden of two operations. It should be performed only in cases in which the operative risk is very great, as by marked debilitation or severe infection.

Although primary anastomosis of the biliary and intestinal tracts has been established as the procedure of choice, it is debatable whether or not the cyst should be excised. Extirpation of the cyst with primary anastomosis of the remaining duct system to the duodenum seems more physiologic, since it creates a more normal union between the liver and duodenum and eliminates the cyst which may harbor infection. This method, however, carries a higher mortality (three deaths in seven reported cases) and should only be considered when the patient is a good operative risk, the cyst large, and infection

minimal or absent. The number of reported cases in which this procedure has been carried out is too few (follow-up reports even fewer) to warrant any conclusions as to the value of the general employment of the method. The authors' Case 1, nevertheless, demonstrates the feasibility of the procedure in a properly selected patient. Anastomosis of the cyst, as in the authors' Case 2, gives satisfactory results, particularly in surgically handicapped patients and is the procedure recommended in the ordinary case. The remaining dilated duct may harbor regurgitated food, however, leading to severe ascending cholangitis (case of Fowler⁹).

The amount of cyst fluid usually varies from 30 cc. to several liters. The aspiration of 5,800 cc. in the authors' Case 2 is most unusual. In the case of Reel and Burrell,¹⁰ disputed by Poate and Wade¹¹ as not being authentic and not included in our previous review, 8,000 cc. are reported. Other authors recording large amounts of cyst fluid are Smith² (Case 1, 5,200 cc.), Yotuyanagi¹² (Case 2, 5,200 cc.), and Fukada¹³ (Case 1, 5,000 cc.).

Little is known about the late results in cases of recovery following operation, as seldom is anything further reported concerning the progress of the patient. McConnell,¹⁴ Berkley,¹⁵ and Gross¹⁶ each reported cases in which the patients were well after four years. Cases reported as well for more than five years are those of Iselin,¹⁷ Hildebrand,¹⁸ McWhorter,¹⁹ Murata,²⁰ Walton,²¹ (second case), Wheeler,²² Sumpter,²³ and Judd and Greene.²⁴ Swartley and Weeder's²⁵ case died ten years later of hemorrhage from esophageal varices due to portal obstruction. The case of McWhorter¹⁹ died 13 years later of uremia with nephrosclerosis, hypertension, and diabetes. Judd and Greene's²⁴ case in a 13-year follow-up is reported by Smith² to have symptoms similar to gallbladder disease. The case of Wheeler²² died 15 years later at the age of 80.

SUMMARY AND CONCLUSIONS

1. Despite the rarity of congenital cystic dilatation of the common bile duct, 182 authentic cases in the world literature, we have personally encountered two cases herein reported.
2. The lesion was suspected preoperatively in both instances. The diagnostic triad—tumor, jaundice, and pain was present in one case, but pain was absent in the other.
3. In Case 2, 5,800 cc. of cyst fluid represent the largest amount recorded in an undisputed case.
4. The safest treatment, and the one recommended for general employment, is primary anastomosis of the cyst to the duodenum. This procedure was successfully performed in Case 2.
5. Extirpation of the cyst followed by primary anastomosis of the remainder of the biliary duct system to the duodenum may be attempted if the lesion is suspected preoperatively, the patient a good operative risk, the cyst large, and infection minimal or absent. The feasibility of this procedure is

demonstrated in Case 1, in which the patient is entirely well three years and eight months postoperatively.

6. A contribution of follow-up studies is needed from authors who report cases of operative recovery, in order to accumulate more conclusive data as to the value of the various surgical procedures and their ultimate prognosis.

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TRAUMATIC RUPTURE OF THE GALLBLADDER

CASE REPORTS

AND

NOTES ON CHOLEPERITONEUM

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SPONTANEOUS PERFORATION of diseased gallbladders is not unusual. Traumatic rupture of normal gallbladders is rare. There is confusion in the literature about the number of traumatic cases reported. Cole,¹ in reporting an instance in 1935, declared that his was the fourth to be presented, whereas Vance,² in 1928, stated that Lewerenz,³ in 1903, recorded 23 instances. In reviewing the literature on this subject, it is evident that several reports on traumatic rupture of the gallbladder lack proof that such a condition existed. Many were recorded in which aspiration of bile-stained fluid was the only evidence upon which the diagnosis was made. Neither operation nor postmortem examination was done. It became apparent that some instances of diseased gallbladder which had ruptured in connection with a vague and inconclusive history of injury were reported as traumatic ruptures. There were also duplications of cases recorded by two or more authors.

When bile is found intraperitoneally following a blow to the abdomen, the most likely source is laceration or tear of the liver. This is due to the size and relative fixation of this organ. Rupture of the bile ducts is next to be thought of because they also are fixed and susceptible to tearing. The ducts are short and well-protected, so that subcutaneous traumatic injury to these structures is rare. The gallbladder is the least likely to be the source of choieperitoneum because this viscus is well-protected under the liver and is mobile. It is only when the gallbladder is distended with bile that it is likely to perforate when a blow is received in this region. The bile cannot escape through the cystic duct and the hydrostatic pressure within the gallbladder becomes greater than the tensile strength of its wall; hence, the "balloon bursts."

In this presentation no instance is included unless there is definite proof of subcutaneous traumatic rupture of the gallbladder, either by operation or postmortem examination. Patients are prone to attribute the development of symptoms to something that happened to them. This is particularly true of abdominal complaints. In most instances the food or drink or alleged trauma has nothing to do with the development of the condition. It has, therefore, been necessary to exclude almost all of the reports where the gallbladder or biliary passages were diseased as evidenced by the presence of stones and pathologic change in the gallbladder wall. War wounds, stab wounds, and gunshot wounds are not included in this review.

Lewerenz,³ in 1903-1904, reported on 63 cases of subcutaneous traumatic rupture of the gallbladder, liver, and biliary passages gathered from the literature, including one instance of his own. In 1905, Ricketts⁴ presented an historical review including both traumatic and spontaneous ruptures. From these two reports the subcutaneous traumatic ruptures of the gallbladders have been taken. No attempt has been made to check their sources. Both authors give fairly complete accounts of each patient, so that it has been possible to segregate the traumatic from the spontaneous ruptures. There are also duplications of reports by the two writers, and these have been checked. Reports occurring in the literature since 1905 have been taken from the original articles.

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1. Robson, Mayo, 1388.⁴ The author reports on a specimen in Guy's Museum, the case of a lacerated gallbladder of a male, age 29, who was kicked in the abdomen, and died on the 178th day following injury.
2. Stuart, 1734.⁴ A male patient, with traumatic rupture of the gallbladder died on the seventh day. Autopsy showed rupture of the fundus of the gallbladder.
3. Alberti, 1747.³ A male was kicked in the abdomen and died after a few hours. Autopsy: Rupture of the gallbladder. The torn place was in the wall adjacent to the liver.
4. Skeete, 1785.⁴ A boy, age 14, had traumatic rupture of the gallbladder. He survived for five weeks. Paracentesis was done, and postmortem examination revealed perforation of the gallbladder.
5. Operator Unknown, 1796.⁴ A male patient, with traumatic rupture of the gallbladder died on the third day. Postmortem examination revealed perforation in the fundus of the gallbladder.
6. Blumenthal, 1847.³ A boy, age 15, fell on his abdomen. There was pain in the region of the liver, icterus, and collection of bile-stained fluid in the abdomen. The patient died after several days. Autopsy: Rupture of the neck of the gallbladder near the cystic duct. The liver was normal. More than a "bucketful" of biliary fluid was found in the abdominal cavity. The peritoneum was thickened.
7. Fergus, Walter, 1848.⁴ Author reports a patient, age 17, with traumatic rupture of the gallbladder. Autopsy revealed the condition.
8. Folsom, 1869.³ A boy, age 12, was kicked in the right side of the abdomen. There was violent abdominal pain. On the following day he had persistent diarrhea. Despite the injury the boy went to school and took part in physical exercises. On the tenth day he became suddenly worse, with vomiting, cramps, and death. Autopsy: Rupture of the gallbladder, with bile in the abdominal cavity. There was also fibrinous peritonitis.
9. Janeway, 1874.³ There was rupture of the gallbladder after a fall. The patient died. Autopsy: Rupture of the gallbladder, with old adhesions which might have made the patient more vulnerable to injury of this organ. There was marked retroperitoneal exudation of bile.
10. Martel, 1882.⁴ A male, age 33, had traumatic rupture of the gallbladder, with peritonitis. He died two weeks after the injury. Autopsy revealed the condition.
11. Dixon, 1887.³ A male, age 32, fell from a considerable height. Besides minor wounds he showed evidence of peritoneal irritation, swelling of the abdomen with fluid, and icterus. Paracentesis in the ileocecal region yielded bile. Cholecystectomy was performed eight days after the injury because of a large tear in the gallbladder. After the operation icterus became more marked. The patient died 17 days after operation of cholemia. Autopsy: In the common bile duct there were two concretions which

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caused obstruction and which were probably carried there by the trauma. Bile had infiltrated along the posterior margin of the ascending colon retroperitoneally. (Note: It is questionable whether this case should be included in this series. The author does not state clearly that these concretions were gallstones, blood clots, or something else.)

12. Moyer, P., 1891.⁴ A male, age 13, had traumatic rupture of the gallbladder, with peritonitis. Death occurred two weeks later. Autopsy revealed the condition.

13. Schopf, 1894.⁴ Author reports a male, age 60, with traumatic rupture of the gallbladder. He was operated upon, but died.

14. Walton, 1897.⁴ A small wound in the fundus of the gallbladder was sutured but the patient died of peritonitis. At autopsy the wound proved to be closed.

15. Bullinger, 1898.⁴ A female, age 23, had traumatic rupture of the gallbladder. Celiotomy was performed, the gallbladder was sutured, and the patient recovered.

16. Munn, Wm. P., 1898.⁴ A male, age 25, at operation, had three pints of bile removed from the abdomen. The gallbladder was sutured, but he died 36 hours after the operation.

17. Thomas, 1898.⁸ A boy, age 14, fell a considerable distance, striking the abdomen. He collapsed, and later complained of pain in the abdomen. There was evidence of peritoneal irritation. Celiotomy was performed the following day. A large amount of bile was found in the abdominal cavity. The gallbladder was completely torn off, so that it could not be sutured. The patient recovered.

18. Caselli, 1898.³ The author describes a case of rupture of the gallbladder which was operated upon and sutured, with recovery. Lewerenz records this case in an appendix to his main article and states that it was taken from an anniversary publication for Durante.

19. Czerny, 1899.³ A boy was run over by a heavy wagon. Despite abdominal pain he was able to walk. There was evidence of fluid in the abdomen and slight icterus. The stool was acholic. Paracentesis four weeks after injury was done, and 4.5 liters of bile-stained fluid were obtained. Celiotomy was performed five weeks after injury, at which time 5.5 liters of bile-stained fluid was removed from the abdomen, and two tears in the gallbladder were sutured. The patient recovered.

20. Cholzow, 1900.³ A male, age 20, was kicked in the region of the liver. He developed jaundice, and there was evidence of fluid in the abdomen. Three paracenteses were done and each time 5.5 to 6 liters of bile-stained fluid were obtained. Celiotomy was performed 43 days after the accident, at which time a large rupture in the gallbladder was found. Cholecystectomy resulted in recovery.

21. Robson, Mayo, 1901.⁴ The patient died as a result of a fall. Postmortem examination showed the fundus of the gallbladder to be perforated.

22. Edwards, S., 1903.⁴ The author reports traumatic rupture of the gallbladder in a boy, age seven. The gallbladder was sutured and the patient recovered.

23. Siegel, 1909.⁵ Mentioned by J. A. Hicks,⁶ in which rupture occurred eight days after the injury. It was thought to be due to extension of gangrene secondary to trauma.

24. Fortier, L. A., 1914-1915.⁷ Author reports a white female, age 11, who was injured 12 days before admission to the hospital. At celiotomy, rupture in the gallbladder was found. The perforation was sutured and a catheter was placed in the gallbladder, and brought out through the abdominal wall. The patient recovered.

25. Fifield, Lionel R., 1926.⁸ Records a male, age 22, who was run over by a cart. Two months later he reported to the doctor because of increase in the size of the abdomen. Celiotomy was performed. A large amount of bile was found in the peritoneal cavity and perforation of the gallbladder, which was sutured. The patient recovered.

26. Robertson, Hugh, 1931.⁹ This is the report of a male, age 11, with ruptured gallbladder hanging by a few threads to an uninjured liver. There was extensive bile peritonitis. The gallbladder was removed and the wound was drained. The patient made a slow recovery.

27. Brown, Henry P., Jr., 1932.¹⁰ This is an instance of a male, age 18, who had been in an automobile accident. There was complete avulsion of the gallbladder, the organ floating free in a pool of blood in the abdominal cavity. Operation was performed 13 hours after the injury, and the patient recovered.

28. Cole, A. V., 1935.¹ A white male, age 50, sustained an upper abdominal injury. Operation was performed two hours afterwards. The gallbladder was perforated. Cholecystectomy resulted in recovery.

29. Roberts, M. A. W., 1937.¹¹ The author reports a patient who had traumatic perforation of the gallbladder together with injury to the left foot, so that an immediate amputation had to be performed. Although there was one small stone in the gallbladder, the author is convinced that it had nothing to do with the rupture. The patient died, and postmortem examination revealed fat necrosis, although no injury to the pancreas could be demonstrated. The stomach contained blood which came from vessels in the duodenum. (Note: Undoubtedly there had been sufficient injury to the pancreas to permit escape of pancreatic juice. Bile alone does not produce fat necrosis.)

30. Hicks, J. A., 1944.⁶ This report concerns the case of a boy, age three, who fell on the abdomen, and was found, on exploration, to have a perforation in the fundus of the gallbladder. The patient recovered.

31. Sengstacken, Royal F., 1944.¹² A male, age 28, was struck in the upper part of the abdomen by the steering wheel of an automobile. At operation, a rent in the fundus of the gallbladder was found. The tear was sutured, the abdomen was drained, and the patient recovered.

32. **AUTHOR'S CASE REPORT.**—A male, white, age 37, was admitted to the King County Hospital at 2:31 A.M., November 22, 1942, following an automobile accident. Examination by the intern at that time revealed evidence of moderate imbibition of beer. He complained of pain in the left leg. Roentgenologic examination showed fracture of the left fibula, without displacement. In the afternoon he complained of epigastric pain, especially on the right side. It was then learned that he had been treated for ulcer about two years previously, although no roentgenologic examination had been done at that time. When I saw him there was considerable pain and rigidity, especially in the right upper quadrant extending downward. Peristaltic sounds were almost absent.

Roentgenologic examination revealed no evidence of air in the peritoneal cavity. The temperature was normal; the pulse 100; blood count and uranalysis were within normal limits.

Operation.—Celiotomy was performed at 8:00 P.M., with preoperative diagnosis of perforated duodenal ulcer. Upon opening the abdomen, however, bile was found in the right gutter extending down to the pelvis. Examination of the gallbladder revealed a rent, about 1.5 cm. in extent, in Hartman's pouch. There was no evidence of injury to the liver, bile ducts, intestines, stomach, pancreas, or any other organ within the abdominal cavity, nor was there evidence of injury to the abdominal wall. No duodenal or gastric ulcer could be demonstrated. The gallbladder appeared normal and contained no stones.

Operative Procedure.—Through an upper right paramedian incision the gallbladder was brought up; the rent in the wall of it was sutured with fine silk; an incision was made in the fundus of the gallbladder and a moderate-sized rubber tube was inserted into the lumen. A purse-string of chromic No. 00 was placed around it and the tube was brought out through a stab wound to the right of the main incision. Most of the bile in the peritoneal cavity was removed by suction. The abdomen was closed.

Postoperative convalescence was uneventful. The patient was moved to the United States Marine Hospital in Seattle on the sixth postoperative day, where he remained for one week. On the tenth postoperative day the cholecystostomy tube was removed. A small amount of bile drained for a day or so after its removal, and the wound healed without evidence of infection. The patient reported to the office for a check-up examination three weeks after operation. In one month he returned to his usual occupation of

fisherman. He was last seen in January, 1945, at which time he stated that he had been in good health and had had no symptoms attributable to the injury.

NOTES ON CHOLEPERITONEUM

In reviewing the literature on traumatic rupture of the gallbladder one is impressed with the treatment of choleperitoneum before the turn of the century. At that time, aspiration of bile or bile-stained fluid was recorded in almost every instance. It seems that the authors were especially concerned with reporting the large amounts of fluid aspirated. This led Lewerenz³ to the correct conclusion that it is not sufficient to aspirate bile but that operative procedure designed to close the wounds from which bile escapes is necessary. He pointed out that repeated aspiration is not only futile but dangerous, and records two instances in which patients died from perforation of the bowel due to aspiration. The mortality was very high with aspiration.

Considerable work has been done to determine the toxicity of bile in the peritoneal cavity. At present, there is no unanimity of opinion on this subject. A few authors believe that bile in the abdomen is harmless.^{13, 14} Of those who state that choleperitoneum is harmful, there are three opinions as to the manner in which it produces toxic symptoms. One group of investigators has concluded that bile causes death due to the toxicity of its components, especially bile salts and bile acids.¹⁵⁻¹⁸ Another is of the opinion that bile is fatal only if it becomes infected, especially with *Clostridium welchii* or a similar organism.¹⁹⁻²³ A third group states that choleperitoneum produces shock by fluid loss from the circulation into the peritoneal cavity.¹⁵⁻²⁰⁻²¹

Much experimental work has been done, especially on dogs and guinea-pigs. It was found that dog bile is toxic to the animals and, when present in sufficient quantities within the abdomen, causes death within 24 hours.¹⁶ Since dog bile contains a high percentage of taurocholic acid it is much more toxic than human bile, which contains mostly glycocholic acid. Confusion arose over the fact that frequently large amounts of bile-stained fluid was removed and called "pure bile."¹⁶ It is now evident that a few cubic centimeters of bile can stain several hundred cubic centimeters of fluid, so that it looks like bile. In none of the reports where large amounts of bile-stained fluid were removed from the abdomen was the bile salt content determined.¹⁶ It is well-established that choleperitoneum sets up severe reactions, causing adhesions between loops of bowel and other structures, and tends to dilute itself markedly by forming a transudate. Cyst-like cavities are formed and these at times reach huge proportions. If the bile that is present in these localized collections of fluid is small in amount there is little systemic reaction. When bile is allowed to spread throughout the abdomen, toxic symptoms develop and death may supervene in a few hours. Unless the condition is relieved, the lymphatics of the peritoneum become obstructed and ascites develops.

This has been recorded by Vance,² who had a patient that died on the 15th

day following laceration of the liver. At first he had pain; then he became markedly jaundiced; icterus gradually disappeared but distention of the abdomen developed. Aspiration revealed bile-stained fluid. Postmortem examination revealed the abdomen distended with bile. A thick coat of brownish material was found over every part of the peritoneal surface. Vance interprets the chain of events as follows: At first, much bile was excreted through a laceration on the under surface of the liver. Most of this bile was absorbed and jaundice was produced. Later, the bile caused a nonseptic peritonitis from chemical irritation, with formation of enormous fibrinous exudate which blocked the pathway of absorption from the serous surfaces. This condition resulted in accumulation of bile in the abdominal cavity and the disappearance of bile elsewhere. Maingot²² reports an instance with similar findings.

Horrall¹⁶ carried out extensive experiments on dogs and found that when bile was spilled into the peritoneal cavity the animals became ill but survived. If an intraperitoneal fistula of the gallbladder was made so that bile was spilling into the peritoneal cavity continuously, all of the dogs died within 24 hours. Intraperitoneal injection of bile in the amount of 5 cc. per kilogram of weight also caused death in 24 hours. In a few instances bacterial growth was obtained from bile of dogs used for injections. Bacteria were also found in the peritoneal fluid in the dogs who died when bile had been injected. These organisms were staphylococci and colon bacilli. Horrall feels that bacteria would not have had time to cause death, as these dogs died within 24 hours. *When sterilized bile was injected intraperitoneally in the amounts of 5 cc. per kilogram of body weight, death, also, occurred within 24 hours, although the cultures were negative.*

Manson and Eginton,¹⁵ in 1938, working with dogs and guinea-pigs, injected human bile, dog bile, ox bile, and *Clostridium welchii* intraperitoneally. They came to the following conclusion: "It is thus seen that bile possesses some specific toxic or devitalizing action, apparently not dependent upon contained *Cl. welchii* or anaerobes liberated upon escape of bile into the peritoneal cavity. This specific toxic action is quantitative and appears to be due to the bile salt content of the bile." They also conducted experiments on bile in the peritoneal cavity producing shock and arrived at this decision: "This experiment seems to confirm the contention that shock due to fluid loss from the circulatory channels must be a factor in the causation of death in bile peritonitis, and it also indicates the therapeutic value of intravenous isotonic colloid solution in the treatment of this condition in dogs." They decided that there are at least two factors causing death in choleperitoneum, and that the primary factor is the toxic effect of bile salts; the secondary factor is the loss of fluid from the vascular system.

There are clinical reports which indicate that bile, as such, is toxic in the human. McLaughlin²³ reports eight instances, three of which were operated upon with recovery. Four died from bile peritonitis in *from 14 to 48 hours after onset of choleperitoneum*. One died without benefit of surgery, having

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been admitted to the hospital *in extremis*. He states that the mortality rate is from 50 to 75 per cent.

Douglas and Turner²⁴ record a patient who died in about 30 hours following operation for common duct stones. Death was due to bile peritonitis, as proved by autopsy. These authors also cite an instance where a patient died 24 hours following the premature removal of a drain. Postmortem examination revealed death to be due to bile peritonitis.

The writer had a patient who had spontaneous perforation of the gallbladder, but who refused operation. She died within 48 hours. Postmortem examination disclosed choleperitoneum. There was no evidence of infection.

In summing up the evidence regarding toxicity of bile in the peritoneal cavity, it seems that most of the careful experimental work points to the conclusion that bile is toxic and is the prime factor in the cause of death; that shock supervenes and plays a secondary but important rôle; and that infection is the least important, but may be a factor if death occurs late. Bile in the abdominal cavity, if present in small amounts, can be tolerated for months, provided it is walled-off. Generalized choleperitoneum is fatal within a short time.

SUMMARY

1. Thirty-one authentic instances of subcutaneous traumatic perforation of the gallbladder have been found in the literature. One additional case is reported, making a total of 32.

2. It is believed that Horrall's¹⁶ conclusion is essentially correct, namely: "Bile peritonitis is caused by the toxic action of bile acids. Bile acids exert a toxic effect on the heart, kidneys, blood, and blood capillaries and on all tissue with which they come in contact. Bacteria have little or no effect if the peritonitis is fatal within a few hours. Secondary surgical shock is a very important result of the toxic action of bile acids."

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SARCOMA COMPLICATING PAGET'S DISEASE OF BONE*

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THE YEAR 1952 will mark a century since Sir James Paget observed his first patient with an unknown disease which he later described and named osteitis deformans. From 1852 to this patient's death in 1867, Paget closely watched the enlargement of the head, the bowing of the bones, and the decrease in height typical of this condition. In 1876, he delivered an address before the Royal Society of London, giving his classical description of osteitis deformans with a report of five such cases. In 1882, he reported seven additional cases.⁴⁴

The description of this "spongy hypertrophy of bone,"²⁶ as given by Paget in 1876, has been unsurpassed, and very little has been added since his time: "It begins in middle age, or later; is very slow in progress; may continue for many years without influence on the general health; and may give no other trouble than those which are due to the change of shape, size, and direction of the diseased bones. Even when the skull is hugely thickened, and all its bones exceedingly altered in structure, the mind remains unaffected."

"The disease affects most frequently the long bones of the lower extremities and the skull, and is usually symmetrical. The bones enlarge and soften, and those bearing weight yield and become unnaturally curved and misshapen. The spine, whether by yielding to the weight of the overgrown skull, or by change in its own structure, may sink and seem to shorten with greatly increased dorsal and lumbar curves; the pelvis may become wide; the necks of the femora may become nearly horizontal; but the limbs, however misshapen, remain strong and fit to support the trunk. In its earlier periods, and sometimes through all its courses, the disease is attended with pains in the affected bones; pains widely various in severity and variously described as rheumatic, gouty, or neuralgic, not especially nocturnal or periodical. It is not attended with fever."⁴³ Virchow suggested the name *leontiasis ossea* for those cases in which the facial bones and skull only are thickened while the other bones escape.⁴³

In the early stages of Paget's disease the involved bones are soft and easily cut with a knife. It is during this time that the weight of the body causes bowing of the long bones. Later the bone becomes hard and further thickened. Microscopically, there is first a replacement of the original bone by connective tissue, and then a substitution of finely porous cancellous bone which gradually becomes harder. Absorption and ossification go on together, but the latter outstrips the former so that the bone becomes thick, though still finely porous. One of the most characteristic features of the

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microscopic picture is the great number and irregular arrangements of the lamellar systems, which is seen in no other disease of bone. This gives what is known as a mosaic structure due to variously-shaped areas of new and old bone separated by ground substance. The medullary cavity is filled with fibrous tissue.⁵

NATURE AND ETIOLOGY OF PAGET'S DISEASE

The nature of this condition is still unknown. Paget considered it to be an inflammatory process, hence he suggested the name "osteitis deformans."⁴³ Looser, von Albertini, Freund, Erdheim, Haselhofer, and others, also thought it most likely a chronic inflammation. They ascribed the frequent development of bone sarcomas to this prolonged chronic inflammation.⁵² Endocrine disorders have been strongly suspected as the etiologic basis, and the most popular theory at the present time is that of parathyroid dysfunction. Since osteitis deformans is somewhat similar macroscopically and microscopically to osteitis fibrosa cystica, it seems reasonable to suspect a related etiologic factor. The blood plasma alkaline phosphatase is greatly increased in osteitis deformans—even more than in osteitis fibrosa cystica. However, there are no symptoms of hyperparathyroidism and no demonstrable parathyroid hyperplasia in Paget's disease, and the blood calcium and phosphorus show normal values.⁵ In the two cases reported by Davie and Cooke,¹⁴ there was microscopic evidence of reduction in the oxyphil cell content of the parathyroids. At the age when Paget's disease, and especially when Paget's sarcoma, is most common, the oxyphil cell content is normally high. They considered this significant because, according to some endocrinologists, these cells may be concerned with elaboration of a growth-retarding hormone. Moehlig and Adler³⁸ believe the pituitary gland is involved primarily and that the parathyroids are affected secondarily.

Some attention has been focused on the thyroid gland as a possible etiologic factor. In several uncomplicated cases of Paget's disease and also Paget's sarcoma, the thyroid gland is reported to have shown an increased fibrosis and decreased glandular tissue element, while several others showed an hyperplasia of the glandular tissue.¹⁴ The adrenals have been mentioned. Other theories of etiology include syphilis, hereditary factors, neuropathies, trauma, bacterial infections, and arteriosclerosis.⁵²

FREQUENCY OF PAGET'S DISEASE

Although hospital records are the most accurate source at the present time, they do not give a true picture as to the frequency of Paget's disease in the general population. Many uncomplicated cases of osteitis deformans never come to the hospital, and in some of the others the diagnosis has been overlooked; also, some complicated cases have been indexed in the hospital records under the complication rather than under Paget's disease itself. In 1927, Bird,³ on examining the records of four large Boston hospitals, found Paget's disease diagnosed once in every 15,000 admissions. This is in agree-

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ment with 1 to 10,000, in 1913, at the Johns Hopkins Hospital,³⁰ 1 to 13,000, in 1915, at Jefferson Hospital,¹³ and 1 to 14,000, in 1938, at St. George General Hospital, Hamburg.¹ Bird further reported that in the Peter Bent Brigham Hospital, where 80 per cent of the admissions had roentgenograms taken, the incidence was 1 to 3,000 admissions. A recent survey at the Pennsylvania Hospital shows one case of Paget's disease in every 2,000 admissions. O'Reilly and Race,⁴¹ in 1932, supplied the following interesting figures (Table I):

TABLE I
INCIDENCE OF PAGET'S DISEASE IN VARIOUS LOCALITIES

Hospital		Incidence
Leeds General	1927-30	1 case in 3,700 in-patients
London Hospital	1926-29	1 case in 1,400 admissions
London Hospital (when bone dystrophies were under investigation)	1930-31	1 case in 260 admissions
Guys Hospital (Orthopedic Department)		1 case in 130 cases treated
Devonshire Hospital for Rheumatic Diseases—Buxton		1 case in 170 cases

In making routine bone examinations, 1933-38, Abel and Hellwagen¹ found one case of Paget's disease in every 1,400 specimens examined. Campbell and Whitfield,⁹ in 1943, reported one case in 650 patients examined roentgenologically at the Albany Hospital. Schmorl,⁵³ in 1932, examining the skeletal systems of all his autopsies on patients over 40 years of age, for a period of five years, found that 3 per cent showed Paget's disease (138 cases in 4,614 autopsies). It seems from the foregoing results that as more roentgenograms are taken, and more special bone studies are being made, more cases of Paget's disease are being diagnosed. It may be that the disease is far more common than we suspect, especially the monostotic type of Paget's disease, where the diagnosis is much more difficult.

INCIDENCE OF SARCOMATOUS DEGENERATION IN BONES AFFECTED WITH PAGET'S DISEASE

Sir James Paget was able to observe 23 cases of osteitis deformans during his lifetime, and eight of these he was able to follow to their death. Of the eight, five died with malignant lesions—three carcinomas, one sarcoma, and one unspecified, which was probably sarcoma. He suggested the possibility that "by some gradual general change the osteitis made the patient very liable to cancer or sarcoma."⁴⁵ Since his time, numerous case reports emphasize the tendency to sarcomatous degeneration of bones affected by Paget's disease. Packard, Steele and Kirkbride⁴² collected 67 cases of osteitis deformans from the literature, five (7.5 per cent) of which died with sarcoma of bone. Bird³ reported an incidence of 11 per cent in the cases of osteitis deformans which he collected, Grunner, Scrimger and Foster²⁴ 9 per cent, and Geschicker and Copeland¹⁹ 5 to 7 per cent. Codman,¹¹ quoting Bird and Sosman, gives an incidence of 12-14 per cent. Coley and Sharp¹², in reviewing 72 cases of osteogenic sarcoma in patients over 50 years of age, found that Paget's disease was the predisposing factor in 28 per cent. Moore³⁹ states that 25 per cent of patients over 50 years of age, having osteogenic sarcoma, are affected with Paget's disease. It was suggested by Abel

and Hellweger¹ that sarcomatous degeneration is so frequent in bones affected by Paget's disease as to warrant periodic roentgenologic studies on all patients with this disease, in order to find the sarcomas early, when they occur.

While most Americans and some Europeans accept the complication of sarcomatous degeneration of bone in 5 to 14 per cent of patients with Paget's disease, others have a different idea. Knaggs,³⁵ in a study of osteitis deformans in 1926, expressed the opinion that "the frequency of sarcomatous degeneration of bone as a complication had been accidentally exaggerated." Speiser⁵⁸ found sarcoma in only 2 per cent of patients with osteitis deformans, yet, he still acknowledged that sarcoma of bone occurs about 30 times more frequently in patients with Paget's disease than in the osseous structures of the general population in the same age groups. Sear,⁵⁵ reporting on cases in Australia, where Paget's disease is so frequent, found sarcoma in only 2 per cent of several hundred cases. He reported that he doubted if there was any relationship between the two diseases. Schurch and Uehlinger,⁵⁴ in their study, found an association of the two conditions so infrequently that they concluded: "Osteitis deformans may, therefore, not be designated as pre-sarcomatous or precancerous."

RELATIONSHIP OF PAGET'S DISEASE TO OSTEOGENIC SARCOMA

If we accept the view that osteitis deformans enhances sarcomatous degeneration of bones, as evidence undoubtedly seems to favor, then what is the explanation? Some are convinced that trauma is the precipitating factor. A fair percentage of cases of osteogenic sarcoma is reported following minor trauma to bones affected by Paget's disease, but in more cases there is no history of injury. Some cases are reported as sarcoma beginning after fracture of a bone showing osteitis deformans. Others report perfect healing of this type of fracture. Stohr⁵⁹ reported 12 cases of fracture of a long bone showing Paget's disease, all of which healed normally, without one developing sarcoma.

Does Paget's disease, itself, predispose to sarcomatous degeneration of bone? It was pointed out by Coley and Sharp,¹² and has numerous times been confirmed, that patients with Paget's disease and sarcoma of bone invariably have the tumor in bones definitely showing osteitis deformans. Von Albertini⁶² described a "presarcomatous change" in the bone marrow of multiple bones in a long-standing case of Paget's disease. There was a predominance of large spindle cells which did not invade or destroy the surrounding tissue. He considered this an intermediate stage between the supposed chronic inflammation of Paget's disease and the highly malignant sarcoma found in other affected bones of the same individual. Speed²⁶ suggests the possibility that "in bones subject to the change of Paget's disease, one might expect a more frequent development of osteogenic sarcoma than in normal bones, because of the substitution with softer and osteoid type of bone, a tissue of younger type, more active cellularly than normal bone—which heals readily after traumatic fracture, as shown by many reports of Paget's disease.

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This osteoid tissue has a less chronologic age and subsequently may, and probably does, undergo malignant change more frequently than normal bone." Jaffe³¹ believes it quite likely that the tremendous proliferative capacity of the tissue involved in polyostotic Paget's disease may, in itself, be the basic stimulus for tumor formation.

CHARACTERISTICS OF COMPLICATING SARCOMA OF BONE

Sarcomas of bone are notoriously varied in histologic structure, and despite numerous attempts, no classification is widely considered adequate. The bone sarcomas complicating Paget's disease are not unlike the uncomplicated sarcomas of bone affecting the general population. Osteogenic sarcoma is the classical example and is predominantly subgrouped as spindle cell sarcoma, mixed cell sarcoma, round cell sarcoma, *etc.* It is interesting to note in six instances (including one case reported at this time) that fibrosarcoma is the histologic type reported. Whether or not these fibrosarcomas take origin from the periosteum, endosteum, or from the abnormally increased fibrous tissue element of Paget's disease is not known. Since these tumors are so few, and since they are so different from those sarcomas arising from osteoblastic tissue, it is questionable whether or not the six fibrosarcomas should be considered in the same category with the large number of true osteogenic sarcomas complicating Paget's disease.

Unlike uncomplicated osteogenic sarcoma, those secondary to osteitis deformans have the peculiar characteristic of often affecting multiple bones of the same individual. Twenty-six of the 76 collected cases (Table II) are known to show sarcoma in multiple bones. This multiple bone involvement is considered by some to be metastasis from one primary site. However, this seems unlikely since only those bones affected by Paget's disease show sarcomatous change and multiple bones may be affected without the lungs, liver, brain, and other viscera being involved.^{52, 12, 14}

Age Incidence.—Osteitis deformans is a disease found in the older age-group. It is rarely seen under 40 years of age. Although Da Costa, *et al*¹³ reported a case of Paget's disease beginning at the age of eight, and Jaffe³¹ another beginning at the age of 28, these are extremely rare. Schmorl¹⁵³ reported that he had never seen osteitis deformans in any form under age 40. Packard, Steele, and Kirkbride,⁴² in their analysis of 51 cases of osteitis deformans collected from the literature, found the average age of onset to be 49.5 years. The span of time between the beginning of the osteitis deformans and the onset of sarcoma is unknown. In Table III, the 76 collected cases of sarcoma of bone complicating Paget's disease have the ages recorded in 74 instances. The average age is 57.7 years—the youngest being 32 years and the oldest 78 years. This shows a difference of over eight years between the average age of onset of Paget's disease, as recorded by Packard, Steele, and Kirkbride, and the average age of onset of the complicating sarcoma in the collected cases.

TABLE II

COLLECTED CASES OF SARCOMA COMPLICATING PAGET'S DISEASE*

Author	Year	Age	Sex	Paget's Disease Sarcoma		Location and Histologic Diagnosis of Sarcoma
				Mono-	Poly-ostotic	
1. Paget (Case 1)	1877	68	M	P	M	Fibrosarcoma of left radius
2. Paget (Case 2)	1877	60	M	P	M	Sarcoma of humerus (no histologic examination made)
3. Howse (cited by Speiser)	1877	65	M	M	M	Spindle cell sarcoma of tibia
4. Goodhart	1878	60	F	P	P	Medullary sarcoma of skull, pelvis, and vertebral column
5. Fielder	1896	45	F	P	M	Mixed spindle and round cell sarcoma about sacro-iliac joint
6. Wherry	1896	56	M	P	P	Periosteal sarcoma of skull and tibia
7. Packard, Steele, and Kirkbride	1901	65	M	P	M	Giant cell sarcoma of skull
8. Von Kutscha	1909	56	F	P	P	Sarcoma of tibia and skull
9. Gruner, Scrimger, and Foster	1912	56	M	P	P	Spindle cell sarcoma of shoulder and radius
10. Ransohoff	1913	49	M	?	M	Round cell sarcoma of tibia
11. Heazlitt	1917	40	M	P	M	Giant cell sarcoma of tibia
12. Carman and Carrick	1921	62	M	P	M	Mixed cell sarcoma of femur
13. Fedder (autopsy by Christeller)	1924	50	M	P	P	Round cell sarcoma of femur, humerus, skull, ribs, and vertebra
14. Camp (Case 1)	1924	70	M	P	M	Sarcoma of femur (no histologic examination made)
15. Camp (Case 2)	1925	60	M	P	M	Osteogenic sarcoma of humerus
16. Cabot	1926	43	M	P	M	Osteogenic sarcoma of neck of femur
17. Pick-Martens (personal communication with Janker)	1926	57	M	P	M	Sarcoma of humerus (rich in cells and with giant cells)
18. Bird (Case 1)	1927	66	F	P	M	Fibrosarcoma of skull with bone formation
19. Bird (Case 2)	1927	60	M	P	M	Sarcoma of ileum (no histologic examination made)
20. Bird (Case 3)	1927	60	M	P	M	Fibrosarcoma of elbow
21. Bird (Case 4)	1927	69	M	P	M	Osteosarcoma of humerus
22. Bird (Case 5)	1927	55	M	P	P	Osteogenic sarcoma of ileum
23. Bird (Case 6)	1927	44	M	P	M	Osteogenic sarcoma of clavicle and scapula
24. Bird (Case 7)	1927	69	M	M	M	Fibrosarcoma of skull
25. Bird (Case 8)	1927	56	M	P	M	Osteogenic sarcoma of femur
26. Bird (Case 9)	1927	45	M	P	P	Osteogenic sarcoma of humerus and tibia
27. Gold	1927	63	M	M	M	Round cell sarcoma of humerus
28. Looser	1928	50	M	P	M	Spindle cell sarcoma of femur
29. Poro (cited by Segale)	1928	66	M	P	M	Spindle cell sarcoma of scapula
30. Segale	1928	50	M	P	M	Round and spindle cell sarcoma humerus
31. Speiser (also published by Albertini)	1928	51	M	P	P	Mixed cell sarcoma of femur and tibia (principally spindle cells with few giant cells)
32. Stohr	1929	72	M	P	M	Mixed cell sarcoma of humerus (principally spindle cell)
33. Wissing (Case 1—autopsy by L. Pick)	1929	53	M	P	P	Round cell sarcoma of clavicle
34. Wissing (Case 2—autopsy by L. Pick)	1929	64	M	P	P	Partly medullary, partly round to mixed cell sarcoma of left foot and skull
35. Genner and Boas	1930	51	M	P	P	Large cell medullary polymorphonuclear sarcoma of scapula, clavicle, and humerus
36. Mathey-Cornat	1930	42	M	?	M	Chondrosarcoma of scapula
37. Ochsner and Gage	1930	61	M	P	M	Osteogenic sarcoma of tibia
38. Breslich	1931	61	M	P	M	Osteogenic sarcoma of tibia
39. Coley and Sharp (Case 1)	1931	63	M	P	P	Osteogenic sarcoma of femur with metastasis to humerus

SARCOMA AND PAGET'S DISEASE

TABLE II (Continued)
COLLECTED CASES OF SARCOMA COMPLICATING PAGET'S DISEASE*

Author	Year	Age	Sex	Paget's Disease Sarcoma		Location and Histologic Diagnosis of Sarcoma
				Mono-	or Poly-ostotic	
40. Coley and Sharp (Case 2)	1931	66	M	P	P	Osteogenic sarcoma of tibia, ulna, and humerus
41. Coley and Sharp (Case 3)	1931	57	M	P	M	Osteosarcoma of humerus and femur
42. Volkmann	1931	53	M	P	P	Spindle cell sarcoma of femur (generalized but only femur histologically proved)
43. Smith	1931	51	M	P	M	Osteogenic sarcoma
44. Gougerot, Isay and Stehelin	1931	?	?	M	M	Polymorphic sarcoma of humerus
45. Wanke	1932	68	M	P	P	Osteochondrosarcoma of femur with multiple primary sarcoma nodules
46. Schmorl (personal communication with Wanke)	1932	63	?	P	P	Multiple sarcoma
47. Gerstel and Janker	1933	78	M	M	M	Spindle cell sarcoma of skull with giant cells
48. Hagenau, Gally, and Daum	1934	62	M	M	P	Osteosarcoma of humerus and femora
49. Perlman	1934	54	M	M	M	Sarcoma which varies from polymorphonuclear to spindle cells of the lower end of the femur and other points
50. Bauzet, Delarue, and Elbim	1935	61	M	P	M	Osteogenic sarcoma of femur
51. Kienbock and Selka	1935	47	M	P	P	Polymorphic sarcoma (with ossification of vertebral column, 6th rib, ilium, and femur
52. Parenti and Ludeke	1935	67	M	M	P	Spindle cell and polymorphic sarcoma of tibia with multiple nodules in other bones
53. Grizaud	1936	32	M	P	M	Sarcoma of femur (no histologic examination made)
54. Jeanneney and Cretin	1936	68	M	P	M	Osteogenic sarcoma of humerus
55. Davie and Cooke (Case 1)	1937	64	F	P	P	Spindle cell sarcoma of humerus and skull
56. Davie and Cooke (Case 2)	1937	42	M	P	P	Spindle cell sarcoma of ulna, vertebral column, femur, and skull
57. Abel and Hellweg	1938	76	M	M	M	Osteoid sarcoma of ilium
58. Rinonapoli	1938	61	M	P	M	Spindle cell sarcoma of humerus
59. Schurch and Uehlinger	1938	55	M	P	M	Osteogenic sarcoma of femur
60. Regan	1938	?	M	P	M	Sarcoma of skull
61. Vater and Abel	1939	63	M	P	P	Osteogenic sarcoma of femur
62. Hansen	1941	52	M	P	M	Osteogenic sarcoma of humerus
63. Speed†	1941	58	F	P	P	Osteogenic sarcoma of tibia, femur, pelvis, scapula, and lumbar vertebrae
64. Metz†	1941	53	M	M	M	Bone sarcoma of radius
65. Meyerding†	1941	44	M	M	M	Giant cell sarcoma of femur
66. Schajowicz	1942	48	M	M	M	Chondrosarcoma
67. Pike (Case 1)	1943	53	M	P	M	Osteogenic sarcoma of lesser trochanter of femur, involving sacrum
68. Pike (Case 2)	1943	62	M	P	M	Osteogenic sarcoma of scapula
69. Pike (Case 3)	1943	63	F	P	M	Osteogenic sarcoma of femur
70. Campbell and Whitfield (Case 1)	1943	52	M	P	M	Chondrosarcoma of sacrum
71. Campbell and Whitfield (Case 2)	1943	53	M	P	P	Osteogenic sarcoma of 6th and 7th thoracic vertebrae
72. Campbell and Whitfield (Case 3)	1943	64	F	P	M	Sarcoma (?) 6th dorsal vertebra (roentgenogram diagnosis only)
73. Kirschbaum	1943	78	F	P	M	Sclerosing fibrosarcoma of skull
74. Authors' (Case 1)	1945	44	F	P	M	Osteogenic sarcoma of tibia
75. Authors' (Case 2)	1945	66	F	P	P	Osteogenic sarcoma of humerus and skull
76. Authors' (Case 3)	1945	50	F	P	P	Fibrosarcoma of skull, ribs, vertebrae, and femur

* This table was revised and 20 new cases added to the one published by Schajowicz.⁸²

† Included in article by Hansen.⁸⁰

Sex Incidence.—In uncomplicated Paget's disease, Bird³ gives a proportion of 65 males to 35 females. Schmorl¹⁵³ gives 58 males to 42 females. O'Reilly and Race⁴¹ think the sexes are affected equally. In the 74 instances of the 76 collected cases of Paget's sarcoma, where the sex is recorded, 62 (84 per cent) are males and 12 (16 per cent) females. Three of the 12 females are reported in this article. Schajowicz⁵² suggested that the prognosis of Paget's disease in women was better than that in men, because the incidence of sarcomatous degeneration reported was much greater in men than women.

LOCALIZATION OF PAGET'S SARCOMA

Table III gives an estimate as to the frequency of involvement of the individual bones with Paget's sarcoma in the collected cases (Table II). All the cases could not be included because a few of the authors did not specify the exact bones harboring the sarcoma.

TABLE III
LOCALIZATION OF PAGET'S SARCOMA

	Femur	Humer- us	Skull	Tibia	Scap- ula	Verte- brae	Ilium	Ribs	Pelvis	Radius	Ulna	Sacrum	Clavi- cle
Monostotic sarcoma	11	11	6	6	3	1	3	0	0	2	0	1	0
Polyostotic sarcoma	13	9	9	7	3	5	3	3	3	1	2	0	3
Total	24	20	15	13	6	6	6	3	3	3	2	1	3

Treatment.—The prognosis in sarcoma of bone complicating Paget's disease is extremely grave. There is no known cure. When possible, early amputation well above the sarcomatous bone, with or without previous roentgenotherapy, seems to be the treatment of choice. For those cases where amputation is impossible, roentgenotherapy seems beneficial. Although the roentgen ray does not stop the growth of the lesion, it often renders the patient free from pain during the terminal stages. Cordotomy has been resorted to in some instances. It was pointed out by Coley and Sharp that those patients having osteogenic sarcoma secondary to Paget's disease have a life expectancy ten months shorter than those with uncomplicated osteogenic sarcoma of the same age-group.

ILLUSTRATIVE CASE REPORTS

Case 1.—G. L., white, female, age 49, was admitted to the Surgical Service of Dr. W. E. Lee, at the Pennsylvania Hospital, on January 18, 1944, with the chief complaint of a large painful swelling on the right lower leg. Three months prior to admission she received an injury to her right ankle which seemed unimportant at the time, but after several weeks there appeared a swelling on the medial aspect which gradually increased in size. Five weeks before admission the tumor had become very large, was reddened, and painful. Her local doctor made a small incision in this area and found spongy friable tissue, which bled profusely. There was a large hemorrhage each time the dressings were changed, thereafter.

Significant physical findings were an extremely thin, pale, emaciated white female. There was prominence of the frontal and temporal bones and the eyes were sunken

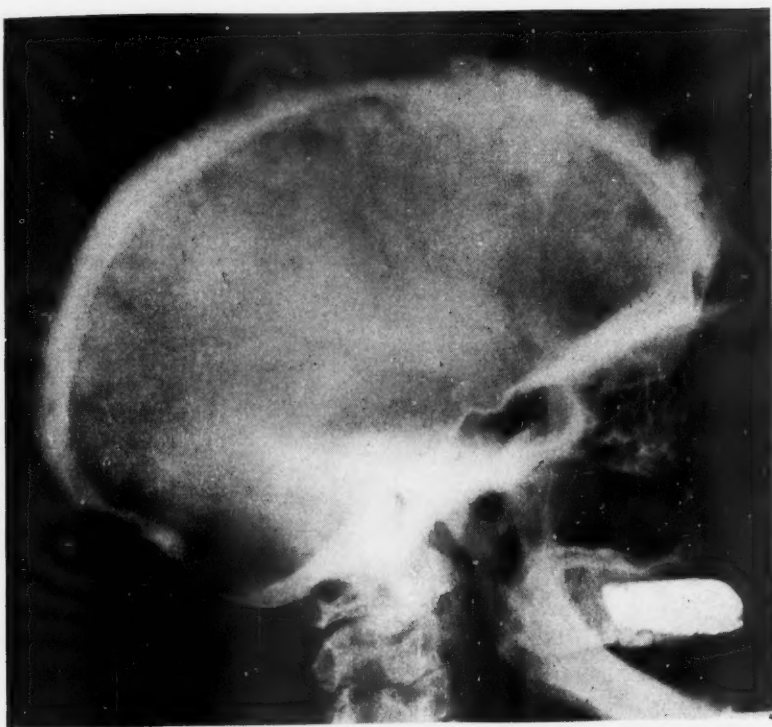


FIG. 1.—Case 1: Roentgenogram of skull showing osteitis deformans. Note the thick "woolly" appearance of the cranial bones typical of this condition.



FIG. 2.—Case 1: Roentgenogram of pelvis. There are trabeculations characteristic of osteitis deformans in iliac bones and femora.

bilaterally. Mucous membranes were generally pale. Over the right internal malleolus was a tumor mass bulging outward 8 by 7 cm., which projected 2 cm. above the surrounding skin. It was ulcerated, red, soft, and bled easily. The ankle and foot were edematous, red and hot. The tibia was roughened and bowed anteriorly. There was marked edema of both hands and arms, and the left foot and leg to the knee.

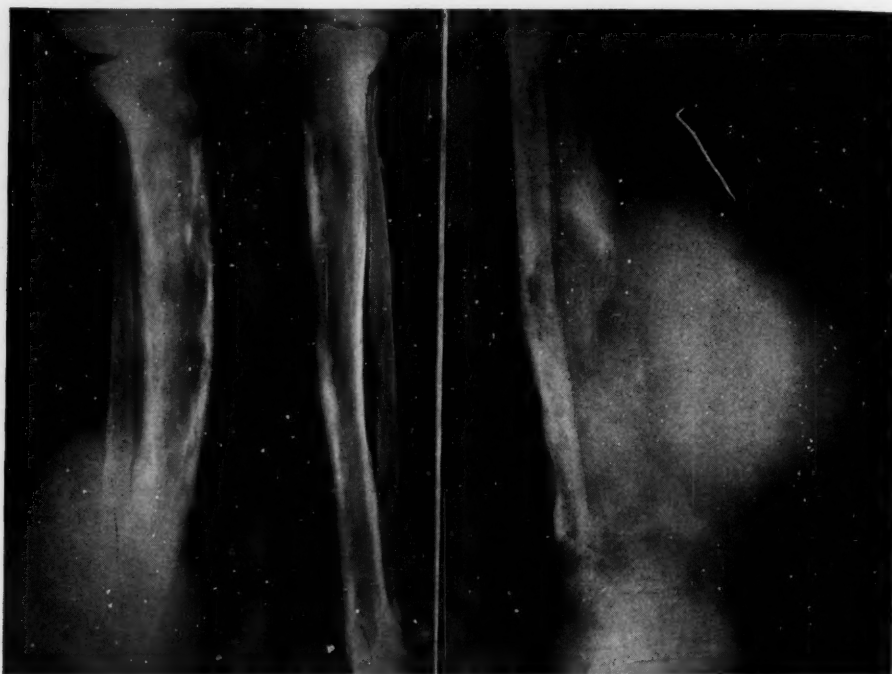


FIG. 3

FIG. 4

FIG. 3.—Case 1: Roentgenogram of bones of leg. Note the marked bowing of the right tibia with rearrangement of trabeculation. The sarcoma is at the lower third of the right tibia.
FIG. 4.—Case 1: Roentgenogram showing osteogenic sarcoma. Note the bone destruction in the tibia with calcification in the soft tissue.

Pertinent laboratory findings were hemoglobin of 8 Gm., erythrocytes 2,400,000, leukocytes 25,000, with 92 per cent polymorphonuclear cells, 6 per cent lymphocytes, and 2 per cent basophils. Wassermann reaction was negative. Total protein was 3.6 per cent, hematocrit 22.3 volumes per cent, phosphorus 2.3 mg./100 cc., calcium 10.4 mg./100 cc., and alkaline phosphatase 21.4 units. (Bodansky)

Roentgenograms showed changes typical of osteitis deformans in the long bones of both lower legs, pelvis, and upper ends of both femora and the skull; and helped to confirm the already suspected diagnosis of osteogenic sarcoma of the left tibia. Preoperatively, she was treated with a high protein, high caloric diet with vitamin supplements, and 1,500 cc. of whole blood and 250 cc. of plasma intravenously.

On January 25, 1944, a low thigh amputation of the right leg was performed under spinal anesthesia, by one of us (T. J. S.). Five hundred cubic centimeters of blood and 250 cc. of plasma were given at operation. Her postoperative course was uneventful, and she was discharged much improved on the thirteenth postoperative day. She was seen periodically in the Out-patient Clinic. In July, 1944, she suddenly became ill from "heart trouble" and died four days later at home. No necropsy was obtained.

Summary of histologic report of surgical specimen (Dr. John T. Bauer, pathologist). (See Figures 5 and 6 for photographs of gross specimen.): Microscopically, the epithelium

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covering the tumor was extremely thin, having been attenuated by the underlying neoplasm. The tumor was growing wildly and consisted of irregular fibroblasts, poorly defined pale masses of a typical osteoid tissue with occasional calcification, and loose reticular tissue in which could be seen irregular bizarre-shaped cells with hyperchromatic nuclei of various sizes and shapes. Many multinucleated cells were present. Many abnormal



FIG. 5

FIG. 5.—Case 1: Photograph of right leg after amputation.



FIG. 6

FIG. 6.—Case 1: Photograph showing the sarcoma after longitudinal section (posterior view).

dividing cells existed. Vacuolated macrophages were present in the edematous cystic spaces formed by the tumor, and in the more cellular areas macrophages were filled with blood pigment. In some areas there were giant cells which contained a dozen and more regular small oval nuclei, similar to those seen in benign giant cell tumor. About some of the small islands of osteoid tissue, osteoblasts were recognized.

A section of the tibia taken from an area above the sarcoma showed a thickening

of the cortex. Numerous trabeculae were present. There was an irregular arrangement of the lamellar systems, giving a "mosaic" structure typical of Paget's disease. There was an increased amount of fibrous tissue between the trabeculae. Both osteoblasts and osteoclasts were numerous. The normal constituents of the marrow cavity had been replaced by fibrous tissue which was surrounded by a pale eosinophilic staining network of bone. *Pathologic Diagnoses:* Osteogenic sarcoma of right tibia. Paget's disease right tibia.

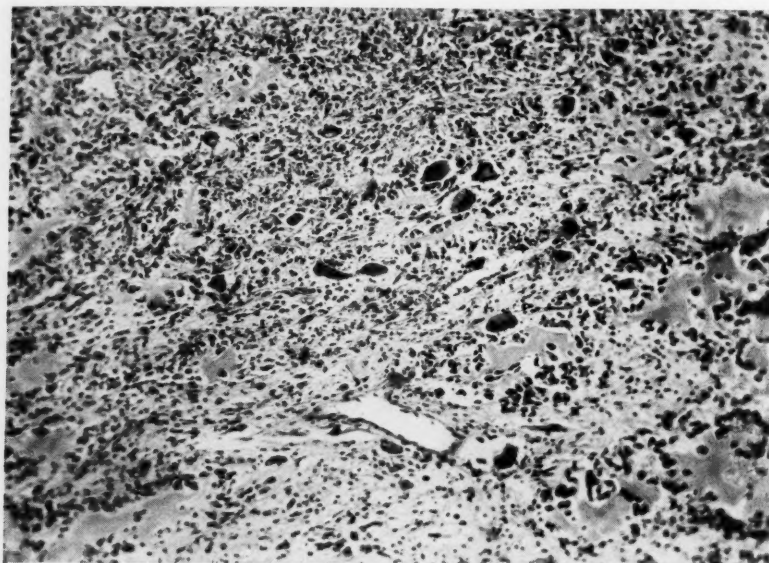


FIG. 7.—Case 1: Photomicrograph showing osteogenic sarcoma. ($\times 120$)

Case 2.—M. K., white, female, age 66, was admitted to the Surgical Service of Dr. W. E. Lee, at the Pennsylvania Hospital, on February 19, 1938, with a chief complaint of a painful swelling of the left arm following an injury four months previously. The immediate reaction was slight but two days later the elbow began to swell and she noticed mild pain in the area. The swelling and tenderness gradually progressed until, at the time of admission, there was a knot the size of a hen's egg on the lower internal aspect of the humerus. She had lost 20 pounds of weight in two months.

Significant physical findings were as follows: Patient was an emaciated white female, apparently chronically ill; eyes were sunken symmetrically. The left elbow showed a fusiform swelling, mostly on the medial aspect. The skin over it was tense and somewhat reddened. The area was hard, not movable, and no pulsations were felt or bruits heard. There was no axillary adenopathy. Flexion and extension of the elbow were limited, but pronation and supination of the hand were normal.

Pertinent laboratory findings were calcium 10.0, phosphorus 3.4, serum alkaline phosphatase 0.70 mg./cc. (Hunsberger method), and Wassermann reaction negative.

Roentgenograms showed well-advanced typical changes of osteitis deformans, or Paget's disease, in the left humerus, pelvis and skull, and confirmed the clinical impression of sarcoma of the left humerus.

She refused operation at this time and was discharged on March 10, 1938, but returned two weeks later with more severe pain, a more advanced lesion and, therefore, consented to operation.

On March 26, 1938, under gas-ether anesthesia, the left arm was disarticulated at

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the shoulder joint by one of us (T. J. S.). Her postoperative course was uneventful, and she was discharged on April 20, 1938, to be followed in the Out-patient Clinic.

She was readmitted to the hospital on August 1, 1938, because of a painful lump, 3 x 10 cm., on the back of the head in the suboccipital region, and numerous smaller

FIG. 8



FIG. 9

FIG. 8.—Case 2: Roentgenogram of skull showing osteitis deformans.

FIG. 9.—Case 2: Roentgenogram of pelvis showing osteitis deformans.

masses on the skull. The corneal reflex (V) was absent on the left side and blurring of the right disk was noted; physiologic cupping was absent in both disks. There was a complete peripheral type facial (VII) nerve paralysis on the left. Roentgenograms

of the skull showed a rounded area of demineralization in the temporal region which was not present on the preceding examination. The lesion was compatible with osteogenic sarcoma of the skull (metastasis?). The lungs were again negative for any evidence of metastasis. After a steady downhill course she died on September 5, 1938.

Photographs of the gross specimen as removed may be seen in Figures 11 and 12. Microscopically, a section through the midshaft of the humerus showed considerable thickening of the cortex with narrowing of the medullary cavity. The cortex had lost its dense character and the architecture was disorganized. Only a few poorly formed haversian canals remained in the outer part of the cortex. There was extensive re-



FIG. 10.—Case 2: Roentgenogram showing osteogenic sarcoma of humerus four months after onset of symptoms. Note the changes of osteitis deformans in the humerus proximal to the sarcoma.

absorption of normal bone by osteoclasts which were present in great numbers. At the same time, there was excessive formation of irregular bony lamellae by osteoblasts. The marrow had lost its blood forming elements and had become converted into a loose vascular fibrous tissue. In the tumor proper there was a proliferation of connective tissue passing through the stages of spindle cell osteoblasts and new bone. The osteoblasts were irregular in size and shape, many of them being pointed in one direction so that they looked like tadpoles. Their cytoplasm was hyperchromatic and their nuclei were oval, vesicular, and deep-staining. Some osteoblasts contained two or more nuclei and occasional mitotic figures were seen among them. The new bone spicules were of irregular shape and many of them were covered by the malignant osteoblasts. The osteoblasts occurred between the spicules as well. In the spicules the osteocytes were of

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irregular shape and hyperchromatic. There were occasional spicules of dark-staining osteoid tissue. A few areas of necrosis were seen and these were infiltrated with polymorphonuclear cells. *Pathologic Diagnoses:* Paget's disease of left humerus. Osteogenic sarcoma of left humerus.

FIG. 11



FIG. 12

FIG. 11.—Case 2: Photograph showing left arm after disarticulation at the shoulder joint.
FIG. 12.—Case 2: Photograph of osteogenic sarcoma after longitudinal section (posterior view). Reprinted by permission, Archives of Surgery.

Summary of pertinent findings at necropsy, performed on September 5, 1938: The skull was thickened diffusely but was thicker in some areas than in others. In the thicker areas of diploe small nodules of firm, rubbery, grayish-white tissue extended both internally and externally from the skull. Some of these compressed the seventh, eighth, and ninth nerves on the left side and involved probably the third and fifth nerves

as well at the base of the brain. Microscopically, the lesions were typical of Paget's disease, with a great deal of new bone formation as well as bone resorption. In some areas the marrow was filled with fibrous tissue. Osteoblasts and osteoclasts were both numerous. In the softer tumor-like areas great proliferation of osteoblastic tissue was present with the deposition of hyaline matrix which was not yet calcified. The cells in these areas were definitely hyperchromatic and anaplastic. Mitotic figures were numerous and multinucleated giant cells were scattered among the smaller osteoblasts. These resembled osteoclasts rather than undivided osteoblasts. Compared with the specimen removed surgically, these nodules and changes in the skull itself were practically identical to those of the humerus. There were no metastases to other portions of the body and, so far as could be determined pathologically, the other bones were unaffected by the process. There was a widespread arteriosclerosis and arteriolosclerosis of the spleen and pancreas. *Pathologic Diagnoses:* Paget's disease of the skull. Osteogenic sarcoma of skull, with compression of left 7th and 8th cranial nerves.

Case 3.—B. F., colored, female, age 50, was admitted to the Norris Medical Service, at the Pennsylvania Hospital, on November 22, 1928. The chief complaint was frequent episodes of nausea with blood-tinged vomitus, and a feeling of weakness and malaise for seven days. She had a mass in the left upper quadrant which she had known to be present for two years, and which had grown steadily in size. This proved to be a large spleen extending to the level of the umbilicus. The liver was not palpable. After studies were completed, the diagnosis lay between splenic anemia (Banti's disease) and myeloid leukemia in the aleukemic phase. After further study as an out-patient, she was readmitted, and the spleen removed on March 20, 1929.

The symptoms subsided remarkably following splenectomy, but after further study, as an out-patient, the diagnosis of chronic myeloid leukemia was established. She was readmitted to the medical service on November 6, 1935, because of progressive pain and weakness of the legs for four months. Pertinent physical findings at this time were a prominent forehead with the temples having a "sunken" appearance. There was a nodule, 1 cm. square, just below the hair border on the right forehead. It was stony-hard and firmly fixed to the bone. There was a generalized lymphadenopathy with hard, discrete, moderately enlarged nodes in the anterior and posterior cervical chains, axillary areas, inguinal areas, and the epitrochlear area on the right. A 3 x 3 x 3 cm. stony-hard nodule was fixed to the second left rib near the costochondral junction. The liver was palpable almost to the symphysis pubis, with the edges smooth and rounded.

Röntgenograms of the chest showed a cardiac enlargement, with lymph node enlargement in each hilus. Examination of the bones showed the ribs to contain numerous areas of rarefaction. These changes were also noted in both scapulae and multiple areas of rarefaction were seen about many of the long bones, especially marked about the knees. There was some thickening of the cortices, evidently due to periosteal reaction. The skull was thicker than normal. After a gradual downhill course the patient died on February 17, 1936.

At necropsy, significant findings were numerous tiny nodules in or beneath the skin of the legs and abdomen. There was a firm white button-like mass on the right frontal bone, firmly attached, which did not impinge upon the brain. The entire skull was thicker than normal. There was a hard white mass firmly attached to the left second rib near the costochondral junction and a similar mass attached to the left femur. The marrow of the ribs, vertebral bodies, and left femur was dull-gray and more abundant than usual. The liver was greatly enlarged. Masses of firm white tissue were seen about the celiac axis, pancreas, and aorta, and similar ones invading the parietal peritoneum, liver, right kidney pelvis and the walls of the left auricle of the heart. Lymph nodes in the abdomen and chest were generally enlarged.

Microscopically, the bone tumors showed many very small spindle-shaped cells with darkly-staining nuclei and a few large multinucleated cells with acidophilic

SARCOMA AND PAGET'S DISEASE

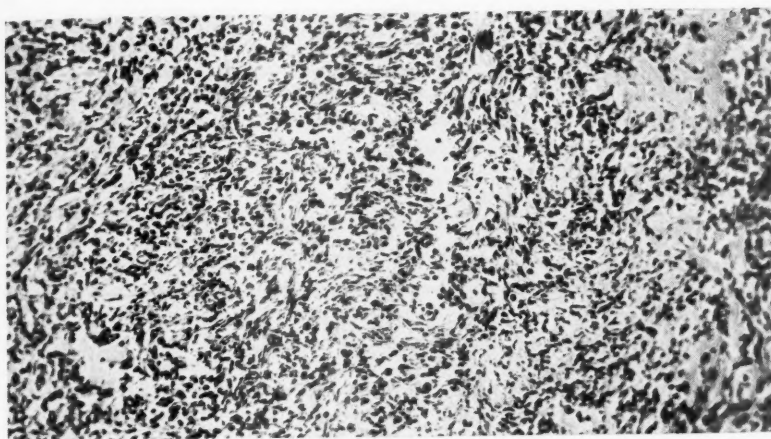


FIG. 13.—Case 2: Photomicrograph showing osteogenic sarcoma. ($\times 120$)

FIG. 14

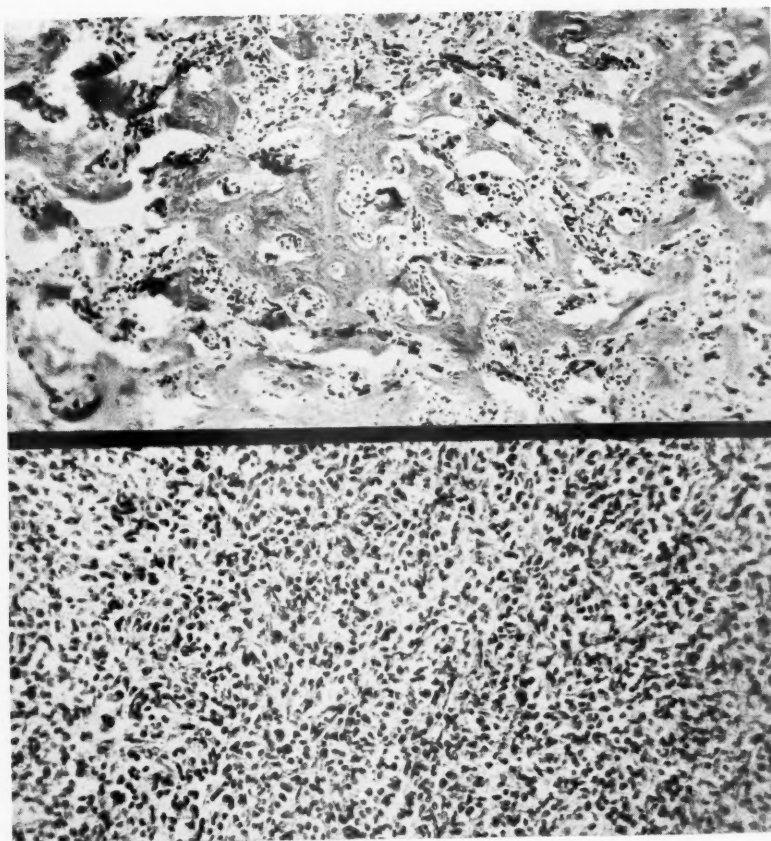


FIG. 15

FIG. 14.—Case 3: Photomicrograph showing osteitis deformans. ($\times 120$)
FIG. 15.—Case 3: Photomicrograph showing fibrosarcoma. ($\times 120$)

cytoplasm. Some of the cells had indefinite cell bodies resembling in some instances fibroblasts with pale vesicular nuclei. The cells showed marked variation in size and shape. Mitotic figures were seen. Fibrous tissue stroma was scanty. There was bone destruction by the tumors but no evidence of osteogenic activity by the neoplastic cells. Sections of these bones taken from areas not involved by the tumors showed thickening of the cortices, with increased trabeculations and increased fibrous tissue proliferation. The white tumor masses described in and about the viscera had a structure similar to that of the bone tumors and apparently were metastases. Postmortem studies of the blood and bone marrow proved the presence of abnormal cells of the granulocytic series compatible with chronic myeloid leukemia. *Pathologic Diagnoses:* Paget's disease, with osteogenic sarcoma of skull, femur, ribs, and vertebrae. Chronic myeloid leukemia.

SUMMARY

1. The clinical and microscopic picture of Paget's disease is given, with a brief discussion as to its nature and the possible etiologic factors.
2. The frequency of diagnosis of Paget's disease seems to vary directly with the number of roentgenograms taken and the number of gross and microscopic bone studies made.
3. There seems to be a definite relationship between osteitis deformans and sarcomatous degeneration of bone. The incidence of bone sarcoma secondary to Paget's disease is given as 2 to 14 per cent; however, some authors deny any relationship between the two diseases.
4. Certain characteristics are peculiar to Paget's sarcoma:
 - (a) It is usually found in patients over age 40.
 - (b) The sarcoma often involves multiple bones simultaneously.
 - (c) Only bones showing osteitis deformans show the sarcoma.
5. The prognosis is very grave, and there is no known cure.
6. Three cases of sarcoma complicating Paget's disease are reported.
7. The literature is reviewed, and an attempt is made to record all the cases of sarcoma complicating Paget's disease reported to date.

We wish to express our appreciation to Dr. John T. Bauer for his help in preparing this paper.

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EXTRADURAL SPINAL HEMORRHAGE

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THE INDIVIDUAL SURGEON must have a very limited experience with extradural spinal hemorrhage, for references to it in the literature are hard to find. It is of special significance on account of the fact that in contradistinction to the usual type of injury of the spinal cord with paraplegia, in this particular syndrome prompt recovery of function is to be expected if a proper diagnosis is made and operation is undertaken at the earliest possible moment.

Case Report.—L. R. a 75-year-old white male, was admitted to the Presbyterian Hospital at 9:45 P. M. on February 18, 1943. That afternoon at 3:30 P. M. he fell four or five feet striking upon his buttocks, and after a few moments he got up and walked up 14 steps into the house. A few minutes later, while sitting in a chair, he felt severe pain in the upper part of his back and down both arms; he then walked to the bathroom and took some medicine to relieve the pain and then returned to the chair. The pain was not relieved, and with help he went upstairs to bed. About half an hour after the accident, while lying in bed, he noticed that his legs were getting weak, and after a few more minutes found himself unable to move them. Numbness in the legs, in the abdomen, and in the chest accompanied the weakness in the legs. The arms were also somewhat numb and the strength in them was diminished. He was taken to the Presbyterian Hospital, where he was seen at 10:00 P. M.

On examination, the patient was alert and coöperative, but unable to make any movement with his legs. There was a sensory level on the trunk at the junction of the third and fourth cervical nerves with the third thoracic segment; on the hands there was an uncertain sensory level at the seventh or eighth cervical segment. Muscular power was entirely lost in the legs and in the trunk, but he could move his arms. There was slight weakness of the biceps muscles, and the triceps muscles were much weaker. He was unable to spread the fingers in either hand, in other words, the interossei were paralyzed, but he was able to use the thumb and the flexors of the fingers in both hands with some diminution in strength. The biceps reflex was present bilaterally; neither triceps reflex was obtained. There was urinary retention and a bilateral Babinski sign. The patient had had an arthritis of the spine for many years and there was a deformity of the whole trunk and neck which were bowed stiffly forward. An attempt was made to do a spinal puncture but, owing to the solid arthritis of the spine, it was impossible to enter the spinal canal. The blood pressure on admission was 120/80 mm. Hg.; temperature 100.4° F.; respiration 22; pulse 100.

Operation was decided upon because of the progressive signs. The patient was first taken to the Roentgenologic Department where anteroposterior and lateral views of the cervical spine were taken. There was complete fusion of all the cervical vertebrae, which was regarded as a Marie-Strumple type of arthritis; there was no fracture-dislocation. A diagnosis of fracture dislocation with compression of the spinal cord at the eighth cervical segment was made before the roentgenograms were seen. Massive extrusion of a cervical intervertebral disk was also considered before reading the roentgenograms, but after these were seen (Fig. 1), it was felt that the most likely diagnosis was extradural hemorrhage of the spinal cord.

Operation.—There were numerous difficulties in operating upon this patient because of the ankylosing arthritis of the spine. The head could not be extended which suggested that there would be difficulty in introducing the intratracheal tube. As a matter of fact, in this position this was found to be easy. The sitting position for operations upon

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the cervical spine, usually adopted here, was not considered feasible and the patient was placed face down in a cerebellar head rest. A midline incision was made over the spinous processes of sixth and seventh cervical and the first thoracic vertebrae. The spinous processes and laminae were exposed and the laminae of the first thoracic and the seventh cervical vertebrae were removed. As the lamina of the seventh cervical vertebra was removed, there was evidence of an extradural hemorrhage. The laminae of the sixth and the fifth vertebrae were also removed exposing the extradural clot (Fig. 2), which measured approximately $4 \times 2 \times 1$ cm. The clot was lifted out in one piece (Fig. 3).



FIG. 1.—Lateral view of the cervical spine showing Marie-Strumpel's type of arthritis, and a coin used as a marker. Lower views revealed no fracture-dislocation.

Following this the dura began to pulsate freely, but there was some bleeding from sclerotic extradural vessels. Muscle was packed in over the bleeding vessels and an iodoform gauze drain was led down to the dura. In this elderly man it was thought to be too time-consuming to stop the bleeding points individually. The wound was closed hurriedly with silkworm gut sutures. An indwelling catheter was inserted immediately after operation.

He was alert and coöperative throughout his convalescence, and there was rapid

improvement in his neurologic condition. By noon of the day following the operation he could make slight voluntary movements of his feet and he could feel the pinprick down to the level of the twelfth thoracic segment. Two days after the operation, the patient could feel the pinprick down to the third lumbar segment, but there was no sensation in the legs below the knee; he had developed more movements in the lower extremities. Three days after the operation, the pinprick was felt over the entire body and movement of the lower extremities was complete, though weak; there were some involuntary twitchings of the left leg. The temperature rose to 103.6° F. in 12 hours following

operation but then remained between 101° F. and normal until the seventh postoperative day, after which it remained normal. The blood pressure remained rather low, 100/50 mm. Hg., or so, for the first four postoperative days and then gradually rose to 130/60 mm. Hg., where it remained during his stay in the hospital. The catheter was removed on the fourth postoperative day, but the patient was unable to void; it was reinserted and left in place until two days before he left the hospital on March 8. During the last week in hospital he continued to improve and was up in a chair every day. He was sent home in the care of his family doctor, who stated that after a few days he was gradually able to walk about and, as his strength improved, he resumed his usual occupation.

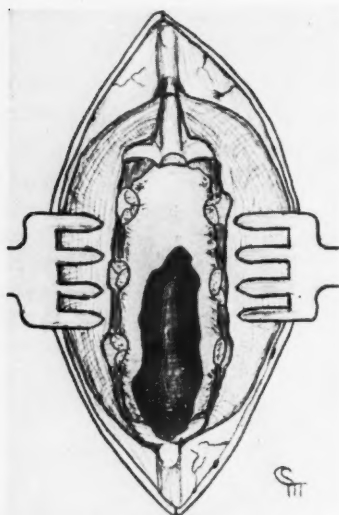


FIG. 2.—Operative sketch by Captain Charles S. Textor II.

establishing a correct diagnosis, which was strongly suggested by the history. In spinal cord injuries it has always been my practice to wait for spinal shock to pass off before considering operative measures. The freedom, for a time, from paralysis, and then its gradual onset suggested an hemorrhagic type of lesion, which it turned out to be. Before the roentgenograms were taken the possibility of a fracture-dislocation occurring in two stages was considered, as was the possibility of severe injury to the neck, with partial displacement of an intervertebral disk subsequently further displaced by movement, resulting in massive extrusion and compression of the cord. The roentgenograms, however, did away with these possibilities, for it seemed impossible for a dislocation to occur or for a nucleus pulposus to herniate in the ankylosed condition of the cervical spine. The most likely possibility, apart from the hematomyelia, was extradural hemorrhage.

It had been my opinion that the condition, though rare, was occasionally seen, but reference to the literature revealed only a few cases. They are of two kinds: those that occurred "spontaneously" and those that occurred as the result of injury. The word hematorrachis was used to describe some of them. Some of the case reports were difficult to evaluate because of incomplete pathologic or operative reports. For the purpose of this discussion only

COMMENT.—The most important point in the consideration of this case was that of deciding to operate upon the patient immediately. This, in turn, depended on

EXTRADURAL SPINAL HEMORRHAGE

those cases of extradural spinal hemorrhage in which the lesion is solely responsible for paraplegia will be considered; there is often both intradural and extradural bleeding in fracture-dislocation of the spine, but these are not the cause of the paraplegia that follows the injury.

The first two cases reported were apparently both "spontaneous" extra-dural hemorrhages, or hematorrachis, as they were called. In 1897, William Bain¹ reported the case of a young housemaid who had suffered for years from constipation. On this particular morning she had great difficulty in moving her bowels. Half an hour later she had severe pain in her back, arms, and legs. She was seen by Bain two hours later, who found that she now had a quadriplegia; she died a respiratory death while he was there.

At postmortem examination an extradural clot was found under the second and third cervical vertebrae. Bain specifically stated that all the other organs were healthy and that the rest of the spinal column was normal. The second case was reported by S. D. Hopkins in 1899, who quoted Bain. This was the case of a middle-aged man, who while shoveling coal, suddenly felt a severe pain in his back. There was severe pain down the legs and tingling sensations. In 20 minutes he could not move his legs. Twenty-four hours later some movement returned in the left leg, but he remained incontinent of urine and feces. Four days after this incident he died, and at autopsy an extradural hemorrhage was found in the lumbar region.

In 1911, A. F. Jonas,⁷ in presenting a paper on spinal fractures before the American Surgical Association, mentioned the case of a 35-year-old farmer, who, ten days before he saw him, had fallen ten feet out of a hay loft. Jonas thought that motor power had been lost immediately and that sensation had been lost gradually over 24 hours. Operation was immediately undertaken (*i.e.*, when seen ten days after the injury), and an extradural clot was found under the fifth and sixth thoracic vertebrae. There is no mention of a fracture-dislocation. The patient recovered function in his legs. It is of interest that Dr. Harvey Cushing was present at this meeting and that he discussed Dr. Jonas' paper at some length.

In 1925, J. Reid and J. Kennedy⁹ described the case of a young woman who fell off her bicycle on September 6, 1925. Witnesses stated that this was a very slight injury, actually she was pushed off her bicycle by a car travelling at about five miles per hour. On September 7 and 8 she had pain in the legs and back; on September 9 she walked into the doctor's office;



FIG. 3.—Extradural clot removed from under the fifth and sixth cervical laminae.

on September 10 she developed a flaccid paralysis, and on September 11 she died a respiratory death. At postmortem examination an extensive extradural hemorrhage was found from the lumbar region to the third cervical vertebra; there was no fracture-dislocation.

In 1935, Hassin and Stone⁵ reported the case of a 32-year-old woman who developed a clumsy and awkward gait two weeks after a normal delivery. This became progressively worse, and the extremities gradually grew rigid, so that the patient frequently fell. Two days after such a fall the patient developed retention of urine and a dull aching pain was felt in the inguinal region. The lower extremities were paralyzed except for some movements in thighs and there was great rigidity. Beevor's sign was present and the lower abdominal reflexes were absent, the upper extremities appeared normal. Changes in sensibility were inconspicuous except for loss of vibration sense to just below the knees in both legs. Spinal puncture revealed a complete block. A diagnosis was made of subacute combined degeneration of the cord with extradural neoplasm at the level of the tenth thoracic segment. At laminectomy, an extradural clot, which resembled a cyst, and which measured $2 \times 2 \times 1.5$ cm., was removed at that segmental level. There was no fracture-dislocation. The patient improved, and at a later date manometric studies showed an absence of spinal block. She died two weeks after operation, with increasing pallor and marked shortness of breath.

In 1941, Wortis and Sharp¹⁰ mentioned extradural hemorrhage in a table in an article entitled "Study of 200 Cases of Spinal Fracture." In this case the hemorrhage was probably not the primary cause of the paraplegia.

Spontaneous extradural hemorrhage causing cord compression is said to occur in hemophilia, and W. M. Priest⁸ described such a case in 1935. There was, however, no direct confirmation of this diagnosis either by operation or autopsy. Charles H. Frazier's⁴ text book on "Spinal Cord Surgery" contains only a reference to Jonas,⁷ and Elsberg's³ book does not refer to this syndrome at all. It is mentioned as an entity in Osler's Modern Medicine, 1928, in the chapter written by Sir F. Farquhar Buzzard and C. P. Symonds,² but no case is quoted, nor is a reference given.

In considering the etiology of these eight cases available in the literature, those of Bain¹ and of Hopkins,⁶ and that of W. M. Priest⁸ are of the so-called spontaneous variety. Priest's case is too poorly documented to be of value. In the case tabulated by Wortis and Sharp¹⁰ the extradural hemorrhage was probably only an incidental finding. Trauma may have been of etiologic significance in the case reported by Reid and Kennedy,⁹ and in the case described by Hassin and Stone.⁵ Jonas' case was certainly secondary to trauma, although the title "Spinal Fractures" is misleading for no fracture was demonstrated in this instance.

The example of extradural spinal hemorrhage reported here did not have a fractured spine and it was improbable that fracture-dislocation could have occurred because of the diffuse ankylosis of the spine. Further, in the two

cases pertinent to this discussion, that of Jonas and that of Reid and Kennedy, a fracture-dislocation of the spine was not found.

Following indirect trauma to the spine, the short progressive history, with the gradual onset of paraplegia in a few minutes or a few hours, and the absence of a bony lesion should strongly suggest extradural hemorrhage of the spinal cord. At all events immediate operation should be performed at the site indicated by the motor and sensory level. A case of extradural spinal hemorrhage is reported in which early operation and removal of the clot was followed by recovery.

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EDITORIAL ADDRESS

Original typed manuscripts and illustrations submitted to this Journal should be forwarded prepaid, at the author's risk, to the Chairman of the Editorial Board of the ANNALS OF SURGERY.

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ANNALS OF SURGERY
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BOOK REVIEW

IN THE DOCTOR'S OFFICE. By Esther Jane Parsons. Philadelphia, J. B. Lippincott Co., 295 pages, \$2.00, 1945.

Here is something worth while! Esther Parsons, as a result of personal observation and experience, is certainly qualified to compile a record of her association with many of our most meticulous professional men. How one can so interestingly and exhaustively set forth the detailed requirements of "a medical assistant" is beyond the reviewer. Certainly, anyone having all the attributes suggested by the author must be a paragon. Nevertheless, the subject matter is most essential for the office assistant to be conversant with, no matter what phase of their duties may be involved.

In addition to the myriad of details essential to the proper conduct relative to the approach to the patient, relation to the doctor, keeping of records, laboratory work, *etc., etc.*, the author has included two Chapters (XIII and XIV) on the "Preparation of Manuscripts" and on the fact that "Doctors Will Write," both of which may be studied by any essayist with advantage both to himself and to the reader, to say nothing of the Managing Editor, the compositor, and to the publishing house to which the article has been submitted.

In short, Esther Parsons is to be congratulated on her excellent compilation of essential data necessary for the production of an efficient "medical assistant," and much that the doctor himself may profit by. It is gladly recommended to anyone seeking proficiency in an essential position, and as a guide to a properly conducted office.

JAMES T. PILCHER, M.D.

ANNOUNCEMENT

The Samuel D. Gross Prize for 1945, in the amount of \$1,500.00, has been awarded to Dr. Robert Elman, of St. Louis, Missouri, for his essay entitled, "Parenteral Alimentation in Surgery: With Special Reference to Protein and Amino-acids."

Others who submitted essays may arrange for their return, if desired, by communicating with Dr. Calvin M. Smyth, Jr., Methodist Hospital, Broad and Wolf Streets, Philadelphia 48, Pa.

Office of Secretary,
Philadelphia Academy of Surgery.

ERRATUM

On the Contents Page of the November issue of the ANNALS OF SURGERY, the paper entitled "A Comparative Study of 100 Fractures of the Shaft of the Femur in which One-Half were Treated with Penicillin," should have been credited to Dr. Spencer A. Collom, M.C., A.U.S., and William McDaniel Ewing, Major, M.C., A.U.S., instead of to Doctor Collom alone. The paper on "Thoraco-abdominal Injuries" is by Reeve H. Betts, Major, M.C., A.U.S.